Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JUNE, 1949

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MESTA

FORGED HARDENED STEEL WORKING ROLLS for Cold Mills

Finishing a 21" x 98" Mesta Forged Hardened Steel Working Roll, for use in modern high speed Cold Reduction Mills as shown above, in a Mesta 28" Travelling Table Type Roll Grinder.

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY · PITTSBURGH, PA.

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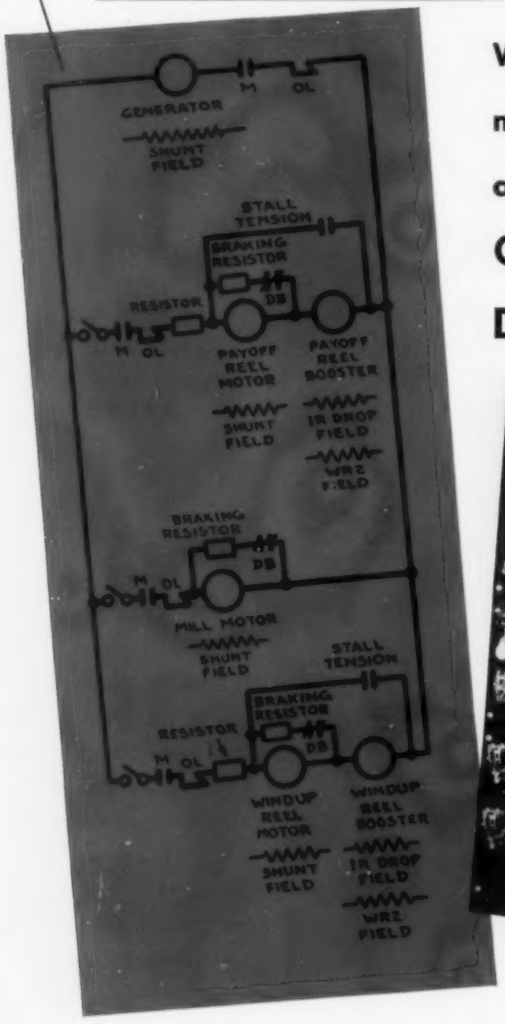
What control for what mill equipment? One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.



When you equip a processing line or group of machines with individual motors supplied by a D-C generator . . . *that calls for a* Cutler-Hammer 14049 custom built D-C Adjustable Voltage Controller

Cutler-Hammer bulletin 14049 control offers any combination of the following functions:

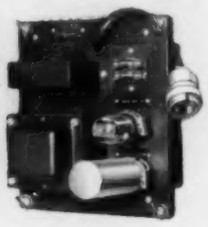
1. Linear speed changes of process equipment by voltage adjustment on the main generator set.
2. Jogging of all units individually or in any combination, either forward or reverse.
3. Pre-selected running speeds.
4. Manual loop control by means of vernier rheostats; or automatic loop control by means of mechanical or photo-electric limit switches or photo-thyratron control.
5. Constant tension control to compensate for changes in coil diameter on uncoilers and/or re-coilers.

Cutler-Hammer bulletin 14049 D-C Adjustable Voltage Control is built throughout to the famed Cutler-Hammer standards of dependability, ruggedness and simplicity. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

TYPICAL COMPONENTS OF CUTLER-HAMMER MILL CONTROL

Cutler-Hammer control desk. Sloping top for easy visibility. Front slanted for toe room.

Synchronous motor starter for motor generator set.



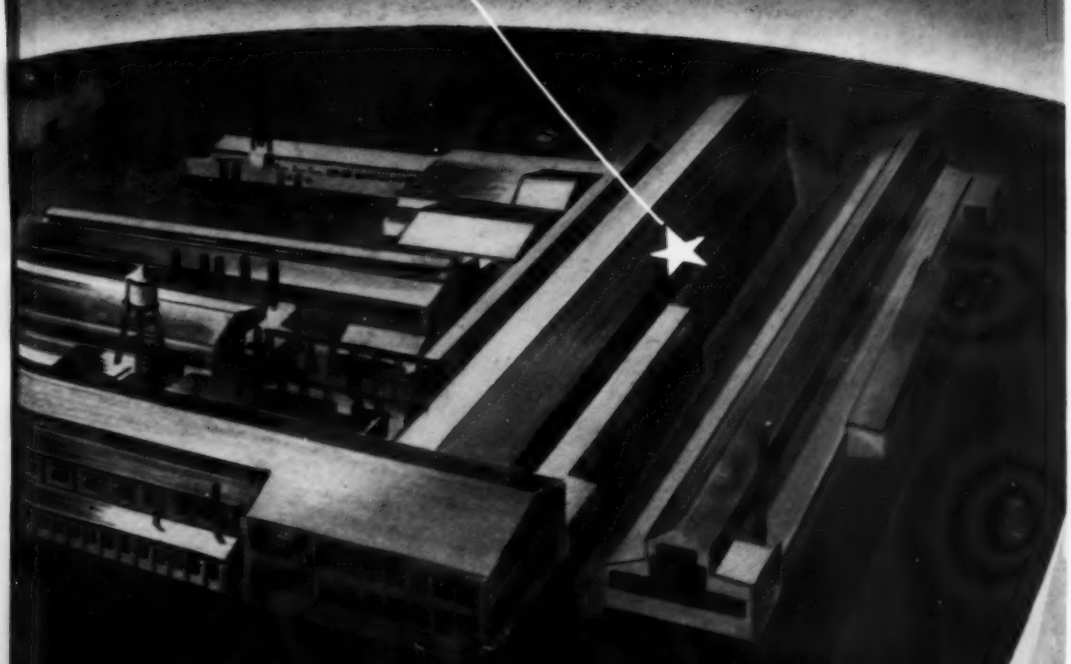
Quick-change unit control panel for photo-electric limit switch.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 26, No. 6.

aetna-standard

One of the world's leading producers of production equipment for ferrous and non-ferrous industries.



Products

Seamless Tube Mills
Piercing Mills
Plug Mills
Reelers
Sizing Mills
Reducing Mills
Continuous Butt Weld Pipe Mills
Continuous Seamless Tube Rolling Mills
Levellers
Shears
Slitters
Tension Reels
Upcoilers
Pilers
Side Trimmers
Stretcher Levellers
Pay-off Reels
Down Coilers
Coil Breakers
Side Trimming Lines
Slitting Lines
Scrubbing and Drying Lines
Continuous Strip Galvanizing Lines
Sheet Galvanizing Lines
Continuous Strip Long Terne Lines
Continuous Electrolytic Tinning Lines
Hot Dip Tinning Equipment
Cutting-off Machines
Continuous Pipe Galvanizing Equipment
Mill Tables
Cooling Beds
Drawbenches
Bar Turning Pointers
Hydraulic Squeeze Pointers
Wire Pointers
Bending Machines
Wire Drawing Machines
Rolling Mill Rolls

THE AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN, OHIO
ASSOCIATED COMPANIES
HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND
AETNA-STANDARD ENGINEERING COMPANY, LTD., TORONTO, ONTARIO, CANADA

NATIONAL ROLLS

a good mark for

STRENGTH
DURABILITY
PRECISION

National Rolls

THE NATIONAL ROLL & FOUNDRY CO.

AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON AND ALLOY IRON ROLLS

The Best Bearing Protection is . . .

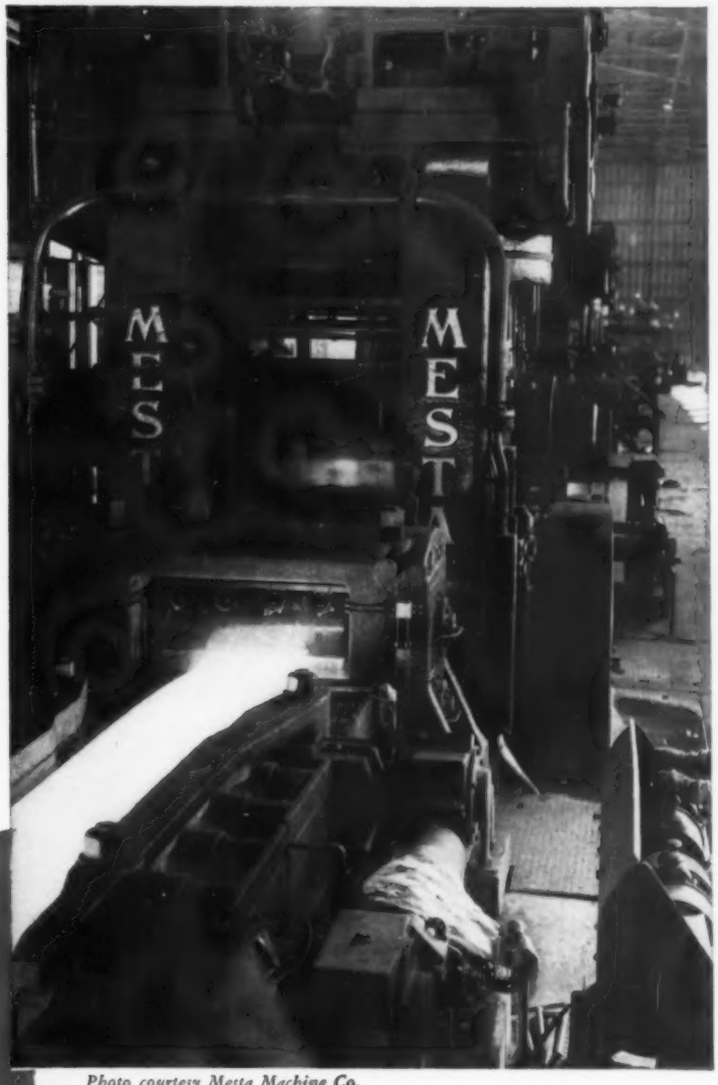


Photo courtesy Mesta Machine Co.

lubrication that keeps the circulating system clean—Texaco Regal Oils

PROLONG the life of your oil film roll necks . . . protect yourself against high maintenance costs . . . by using *Texaco Regal Oils* in your circulating systems. These turbine-grade oils are notably resistant to oxidation, emulsification and sludging. They keep the system clean.

Texaco Regal Oils easily carry heavy loads . . . take high temperatures and high speeds in stride. They assure the smooth, trouble-free performance that means greater production . . . less servicing . . . lower costs.

Your heavy-duty enclosed gears should have the protection of *Texaco Meropa Lubricants* — specially designed for high load-carrying capacity. You'll get longer life for both gears and bearings.

Assure maximum efficiency and economy throughout your plant by the use of Texaco Products and Lubrication Engineering Service. Just call the nearest of the more than 2300 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 E. 42nd St., New York 17, N. Y.

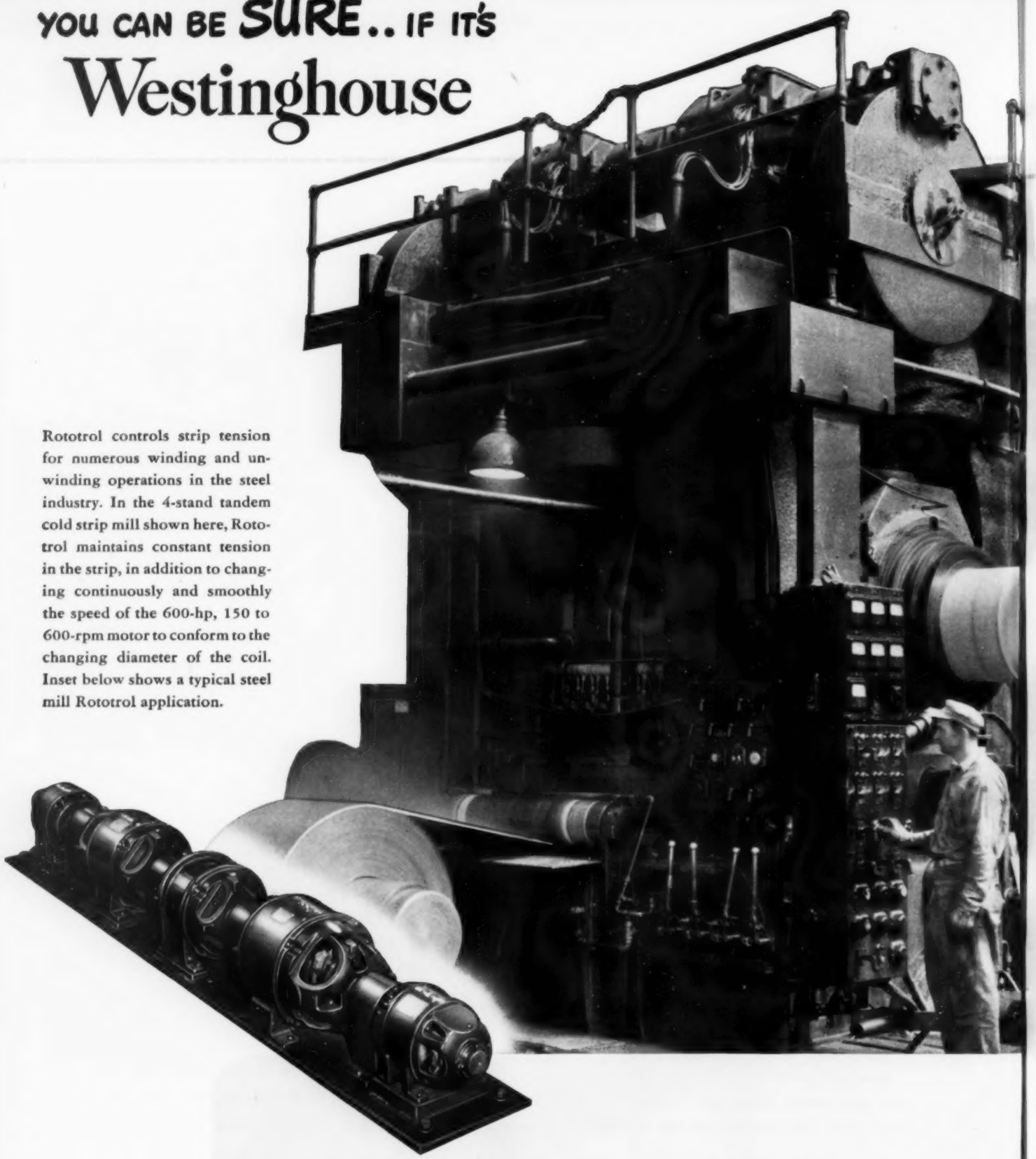
TEXACO

TEXACO Regal Oils
(HEAVY CIRCULATING OILS)

Tune in . . . TEXACO STAR THEATRE every Wednesday night starring Milton Berle. See newspaper for time and station.

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



Rototrol controls strip tension for numerous winding and unwinding operations in the steel industry. In the 4-stand tandem cold strip mill shown here, Rototrol maintains constant tension in the strip, in addition to changing continuously and smoothly the speed of the 600-hp, 150 to 600-rpm motor to conform to the changing diameter of the coil. Inset below shows a typical steel mill Rototrol application.

INTERACTION OF FIELDS DOES IT ALL

The Westinghouse Rototrol is made exactly like a small, d-c generator, except for several additional field windings. It functions entirely through the smooth interaction of these fields.

Having no mechanical—and very low electrical—inertia, Rototrol responds quickly to deliver the required control power. It brings new standards of perfect performance to almost any repetitive process in the steel industry.

The simplicity of operation makes the Rototrol easy to maintain. It gives unvarying performance indefinitely. It is easily serviced by nontechnical men, and its rugged construction stands up superbly to the rigors of steel mill use.

J-94796

Where else can YOU use ROTOTROL to speed up steel production?

Rototrol—the electrical intelligence—has an outstanding record of accomplishments in the steel industry. By providing smoother, more accurate control of a wide variety of steel processes, it has brought increased production and lower costs.

Here are some of the jobs it is doing:

for skip hoist drives—regulates speed better . . . widens speed range . . . simplifies control.

for blooming mill drives—forces action . . . brings faster, smoother reversals.

for tandem cold strip mills—improves control over stand speeds, acceleration, slowdown and stopping.

for processing lines—matches speed . . . makes possible more rapid acceleration and deceleration . . . minimizes necessary down time.

for flying shear—combined with electronic control, matches speed of shear with that of the mill . . . cuts to close tolerances . . . reduces maintenance costs.

for runout tables and coilers—matches table and coiler speeds accurately with mill speed . . . simplifies operation.

for a-c and d-c generators—regulates voltage . . . holds voltage to preset values . . . returns immediately after changes in loading.

for twin-motor drives—balances load . . . eliminates complex electrical connections.

for rod mills—combined with electronic regulators, matches motor speeds accurately . . . virtually eliminates impact speed drop.

for piercing mill drives—controls stability . . . enables motor to carry high peak loads without pull-out . . . often reduces size and cost of motor needed.

for arc furnaces—regulates power . . . changes electrode position quickly and accurately . . . reduces electrode breakage.

for synchronous motors—regulates voltage automatically . . . adjusts excitation . . . improves power factor.

These applications are suggesting even further uses for Rototrol in the steel industry. There is no foreseeable limit to the improvements possible in steel production methods through better electrical control.

Let Westinghouse applied engineering help you develop and apply new methods and equipment for your specialized requirements. Westinghouse specialists in steel industry applications will be glad to work with your own engineers in studying your operations. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

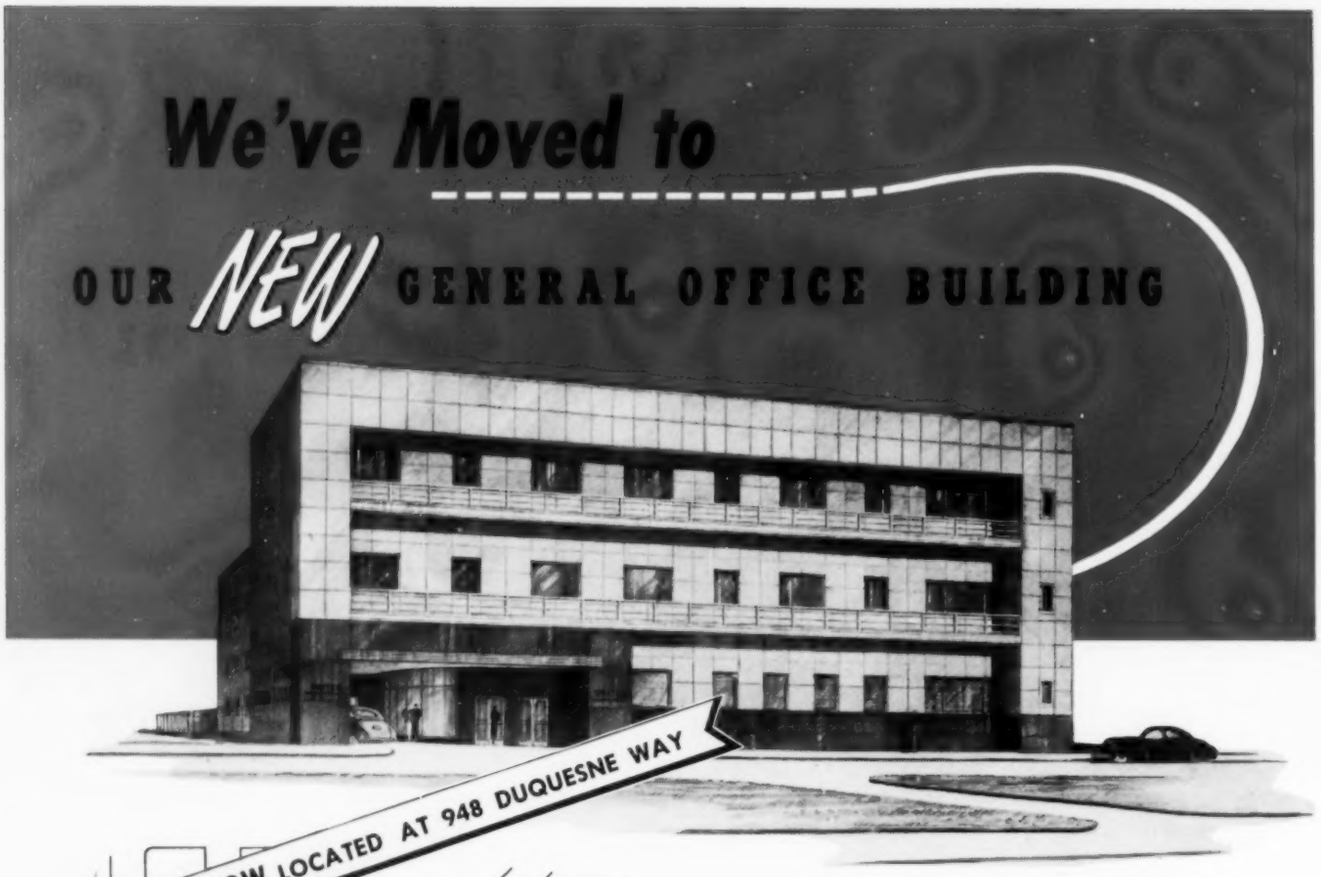
"ROTOTROL IN THE STEEL INDUSTRY"

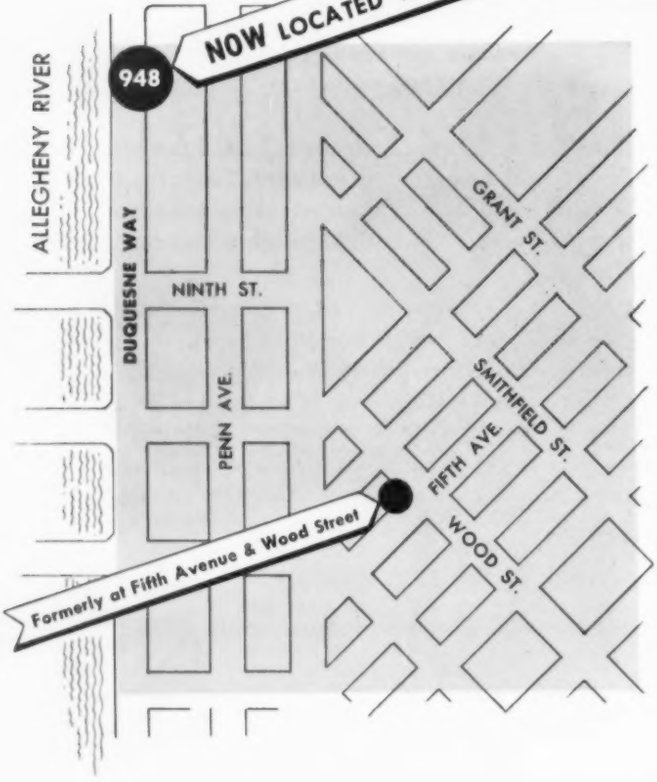
This 24-page booklet tells the complete story of Rototrol in the steel industry, its functions . . . its applications . . . its remarkable accomplishments as a control for steel-producing machinery. Ask your nearest Westinghouse District Office for a copy of B-3998.

Westinghouse

We've Moved to

OUR NEW GENERAL OFFICE BUILDING





In this modern structure we have brought together, under one roof, many United departments formerly located in the First National Bank Building and in other downtown office buildings. You may now contact our Executive, Legal, Sales, Engineering, Research and Development, Production, Purchasing, Traffic, Treasury and Industrial Relations departments through our Main Reception Office in the lobby.

Located between Ninth and Tenth Streets, on Duquesne Way, our new home is within walking distance of Pennsylvania Station, the city's principal bus terminals and the heart of the Golden Triangle. Visitors' parking facilities are available for your convenience.

We extend you a cordial invitation to visit us, and we hope that the concentration of our administrative activities at this new location will result in the saving of valuable time for you and add measurably to your convenience.

UNITED ENGINEERING and FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA, U. S. A.

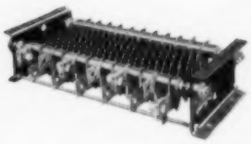
Plants at PITTSBURGH • VANDERGRIFT • NEW CASTLE • YOUNGSTOWN • CANTON

Subsidiary: Adamson United Company, Akron, Ohio

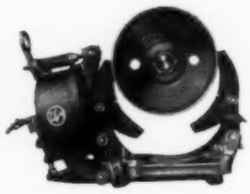
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England; Dominion Engineering Works, Ltd., Montreal, P. Q., Canada; S. E. C. I. M., Paris, France

Designers and Makers of Rolls and Rolling Mill Equipment

Complete Control for Cranes



TAB - WELD Resistors — no burning where burning would cause high up-keep.



LONG-LIFE Brakes give high speed performance — with low up-keep.

SHORT-THROW Narrow-width Cam Master switches are easy on the operator.

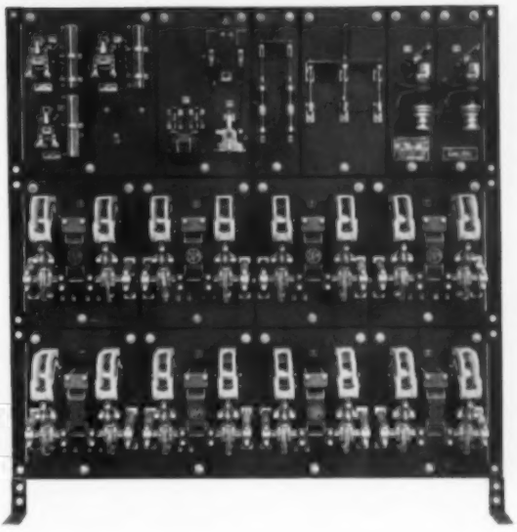
YOUNGSTOWN Safety Limit Stop— a positive check against human error.

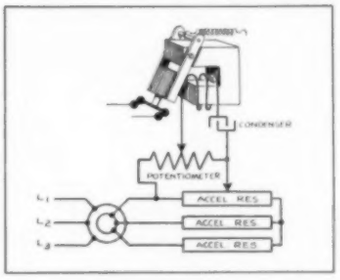
EC&M FREQUENCY RELAYS Improve A-C Crane Performance These Three Ways....

1. *Good inching* because weak values of motor torque are provided.

2. *Plugging-point* controlled with precision by one adjustable relay.

3. *Smooth acceleration* over entire speed. range of motor—heavy loads do not overshoot regenerative lowering speed.



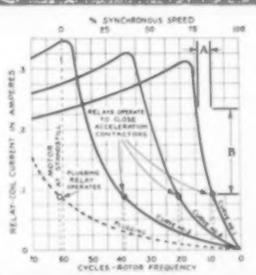


The Changing Rotor Frequency— EC&M uses this motor characteristic for accurate performance

At standstill, the induced frequency in the secondary of a wound-rotor motor equals the frequency of the voltage applied to the motor-primary. As the motor accelerates, the secondary frequency declines. During a plugging operation, the frequency may be as much as double the frequency of line voltage. This varying frequency provides an accurate means for controlling acceleration contactors which insert or remove secondary external resistance to give the desired performance.

Equally important is the quick pick-up and clean drop-out of EC&M Frequency Relays at different frequencies. Each relay operates from a resonant circuit. Previous relays of standard design and connected to the rotor circuit were handicapped by a narrow range of adjustment with resultant high maintenance to keep them adjusted. EC&M Frequency Relays not only eliminate adjustment-maintenance but permit liberal latitude in motor operation without sacrificing safety. For A-c cranes, specify EC&M Frequency Relay Control.

ACCURATE Overload Protection — Magnetic balance absorbs high starting currents, allowing low relay-setting for running-conditions.



ACCURATE Operation from motor-secondary made possible by frequency relays.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 East 79th Street • Cleveland 4, Ohio

Approximately 30,000 miles of rails were rolled last year on the Nation's rail mills. A substantial portion of this rail "mileage" traveled through mills using Phoenix rolls.

Phoenix "A" Rail Roughers, Phoenix Metal Rail Intermediates and Phoenix Special Rail Finishing rolls are well known throughout the steel industry for their ability to produce high tonnages of rails rolled to close tolerances to meet the most exacting requirements — all at less cost per ton of steel rolled.

PITTSBURGH ROLLS Division of Blaw-Knox Company, Pittsburgh 1, Pa.

PITTSBURGH ROLLS

8 outstanding N.B.M. BABBITTS

Help Give You Better Bearing Performance . . . Longer Bearing Life

Good babbitt is the result of using Virgin Metals, correctly proportioned and blended under close laboratory control. You find *all* these qualities in N-B-M Babbitts.

The 8 N-B-M Babbitt Metals shown are the result of years of research combined with actual engineering analysis of all types of bearing lining problems. Each of these N-B-M Babbitt Metals is "custom-alloyed" for specific types of service conditions. Thus, each has definite advantages over so-called "all-purpose" babbitts—advantages that result in longer, more economical bearing service.

These "Custom-Alloyed" bearing lining metals have effected important savings in plant maintenance—and big improvements in product performance. Every Product Designer or Plant Engineer should have engineering data on the complete line of these better N-B-M Babbitt Metals.

Here is Complete Data on N-B-M Babbitt Metals . . . This folder describes all 8 N-B-M Babbitt Metals, giving data on application, physical properties, preparation of bearing shells and pouring. Write for your free copy!

N·B·M

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

ST. LOUIS 10, MO. • MEADVILLE, PA.

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

New... HIGH SPEED BIG TONNAGE *'Surface'*

★AT WEIRTON STEEL COMPANY... each 'Surface' Annealing Cover provides capacity for 20 giant coils of light gauge steel for tin plate and zinc coated materials... each coil containing a single strip that is 5 miles long and weighing about 15 tons.

A combination of many outstanding 'Surface' developments and improvements makes this most recent 'Surface' Annealing Cover installation a unique operation providing maximum efficiency, economy and fast, quality production. Equipment includes 12 bases, 4 radiant tube heated covers, and 2 NX Gas generating units, each with a capacity to produce 20,000 cu. ft. hr. of nitrogen gas.

Coils up to 66-in. O. D. with a 16½-in. I. D. can be annealed, effecting many mill economies such as minimum shut-downs for re-threading. Large coils means reduced handling costs all along the production line.

High Speed and Big Tonnage are augmented by *top quality control* . . . making possible a product that is definitely improved for electrolytic tin-plating or other coating.

From Ingot to Finished Products, 'Surface' has pioneered in equipment for the steel industry including modern One-Way Fired Soaking Pits; Slab, Billet and Bloom Heating Furnaces; Continuous and Batch Normalizers and Annealers; Muffle and Radiant Tube Fired, Controlled Atmosphere Furnaces, and many other types of heating and heat treating equipment.

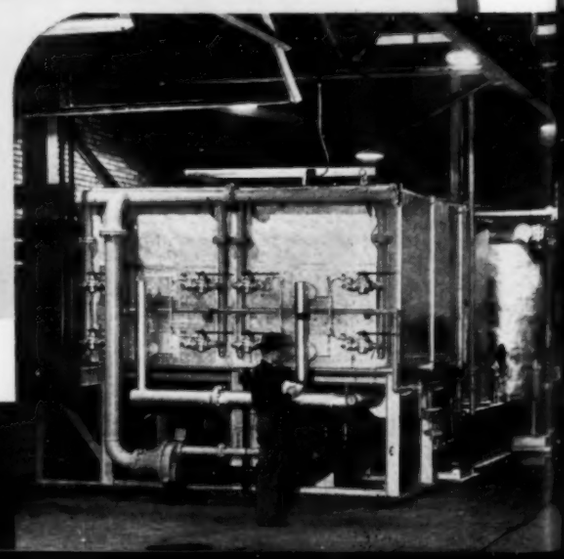
Ask 'Surface' Engineers for up-to-the-minute recommendations on equipment needs *wherever heat is used in the steel industry.*

DEVELOPMENTS AND IMPROVEMENTS MAKE POSSIBLE SPEED AND UNIFORMITY OF STRIP COIL ANNEALING

1. **Coil Separator**—Of simple, rugged construction for balanced convection heating and cooling. Directs rapidly circulated heating and cooling gases to the ends of the coil laminations thereby utilizing solid metal heat transfer, rather than conduction through laminations.
2. **High Powered Base Fan**—'Surface' design. Power input ten times greater than used formerly. Incorporates a unique method of sealing annealing atmospheres against differential pressures.
3. **Corrugated Inner Cover**—Deep corrugations absorb and transfer the heat to the circulated gases within the inner cover during the heating cycle and speed cooling of the charge by reason of the large area exposed.
4. **Radiant Tube Heating Cover**—Stepped-up useful heat input of 'Surface' Radiant Tubes balance the fast heat absorption rate of the new deep-corrugated inner covers and fast heat transfer of base fans and coil separators.

. . . and for Quality Control

5. **NX Annealing Atmosphere Generator**—Furnishes a gas atmosphere environment for the steel, producing the highest quality electrolytic tin plate. Tin plate annealed in 'Surface' NX Gas Atmosphere shows high corrosion resistance, more uniform plating, and fewer plating defects.

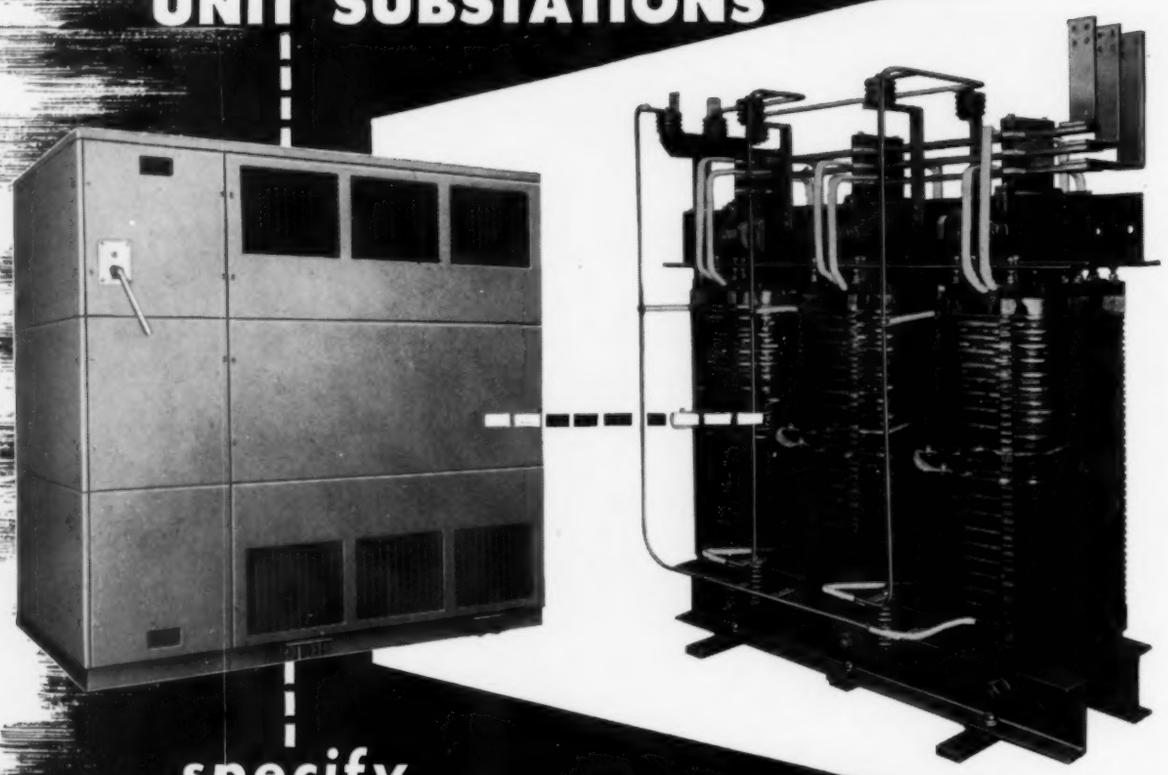


SURFACE COMBUSTION CORPORATION
TOLEDO 1, OHIO
FOREIGN AFFILIATE COMPANIES
[illegible] LIMITED CHESTERFIELD STEIN & ROUBAIX PARIS LIEGE AND GENOA

COIL ANNEALERS •

when buying

UNIT SUBSTATIONS



specify

Wagner TRANSFORMERS

AVAILABLE IN RATINGS FROM 100 TO 2000 KVA

More than fifty years of transformer building experience has been incorporated in the design and construction of Wagner dry-type load-center transformers. Especially developed to meet industry's need for larger transformers for use in plant power distribution circuits, these units are compactly housed in neat, attractive enclosures, which can be arranged to include primary and secondary switchgear compartments to form readily accessible, closely-coupled unit substations. Complete enclosure of all equipment protects against accidental contact with live parts. Relatively light in weight, so they can be used in multi-story buildings, they are readily adaptable to any installation requirement.

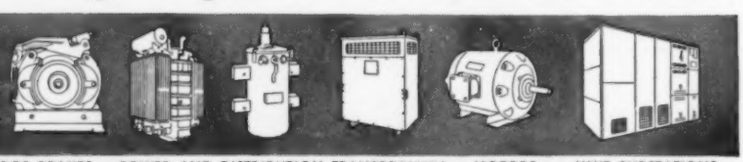
Bulletin TU-56 describes in detail the transformers, the enclosures, the various types of incoming line sections available, and the optional equipment and accessories that can be furnished. Write for your copy today.

Wagner Unit Substation Transformers are also available in oil-filled and Noflamol types. Bulletin TU-181 gives information on the complete line of Wagner Power Transformers.

Wagner Electric Corporation
6483 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.

Consult Wagner Engineers on All Transformer Problems

Wagner Electric Corporation
EST. WE 1891



BRIDGE BRAKES • POWER AND DISTRIBUTION TRANSFORMERS • MOTORS • UNIT SUBSTATIONS

ELECTRICAL EQUIPMENT AND AUTOMOTIVE BRAKE PRODUCTS

T49-3A

100-ton capacity, 88'4" span Steel Mill Crane with 25-ton capacity Auxiliary Hoist installed in a continuous strip mill.

"Shaw-Box" is Back Home again . . .

For many years production of steel mill cranes formed a large part of "Shaw-Box" production. But during the war years, our facilities were required for other types of cranes.

Except for two of our specialties that play an important part in steel mill operations (plate handling cranes and soaking pit carriages) "Shaw-Box" steel mill cranes have not been available to potential buyers for the past three years.

Now we have come back home. Again we offer to steel mills the advantages of "Shaw-Box" engineering experience in interpreting the individual mills crane specifications and their modern manufacturing techniques in producing them. Result . . . "Shaw-Box" steel mill cranes are again available at attractive prices.

Always "Shaw-Box" steel mill cranes have been acclaimed as excellent, rugged cranes that perform with a minimum of attention for maintenance.

Be sure to send all your inquiries and specifications for cranes and soaking pit carriages to "Shaw-Box."

MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION

MUSKEGON, MICHIGAN

USE ALLIS-CHALMERS AIR BLAST METAL-CLAD

For Tough START STOP Drive Duty!

- CLEARS CIRCUITS IN MINIMUM TIME
- INTERRUPTS ARC IN LESS THAN ONE CYCLE
- WITHSTANDS REPEATED "CLOSE-OPEN" OPERATIONS

PRE-STORED AIR supplies the energy for high-speed circuit interruption. Allis-Chalmers Air Blast circuit breakers are guaranteed eight-cycle units but they have consistently completed interruption within four or five cycles. Arcing time, covering the entire range of current values (magnetizing, full load, short circuit), is approximately one-half cycle. With such short arcing time contact burning is reduced, contact life increased. This extra contact life plus the sturdy overall construction fully equips these Air Blast breakers for the severe "close-open" duty cycles required in steel rolling.

ONLY A-C CAN SUPPLY THIS SWITCHGEAR

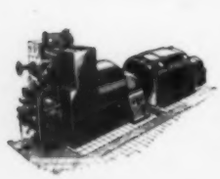
Allis-Chalmers is the only company building vertical lift metal-clad switchgear equipped with Air Blast circuit breakers. With these units circuits are centralized in compact units, saving space and assuring complete safety for personnel.

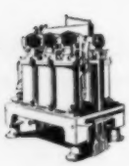
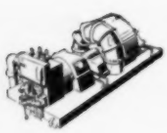
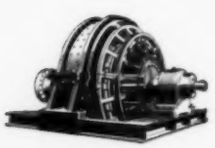
The vertical lift feature simplifies circuit breaker removal for test, inspection and maintenance. The switchgear units are assembled in groups as large as can be conveniently handled in shipment and during installation. They are factory wired and tested; only the power source and feeder circuits have to be connected when switchgear is installed.

For the complete story on Allis-Chalmers Air Blast Metal-Clad switchgear, get Bulletin 18B6760. Ask your nearby A-C representative for a copy, or write direct. A2686

Regulex and *Texrope* are Allis-Chalmers Trademarks.

ALLIS-CHALMERS, 1020A SO. 70 ST.
MILWAUKEE, WIS.



POWER & ELECTRICAL — Steam Turbines, Condensers, Water Conditioning, Power Transformers, Switchgear, Unit Substations, Circuit Breakers...

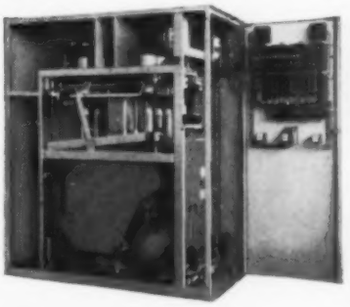
UTILIZATION & PROCESS — Motors, Blowers, Rectifiers, M-G Sets, Betatron, Pumps, Compressors, *Regulex* Exciters, *Texrope* V-Belt Drives ...

CLAD SWITCHGEAR

Designed for Easy Access

ALLIS-CHALMERS switchgear structures are equipped with a motor-driven vertical lift elevating mechanism. The circuit breaker is automatically lowered to the floor of the unit. From there it can be easily wheeled to a test stand where it is fully accessible for test, inspection and maintenance.

Interlocks and automatic shutters protect operators. The breaker cannot be connected to or disconnected from primary contacts when in the closed position. As the breaker is lowered, shutters automatically close off the disconnect openings, preventing accidental contact with live parts.

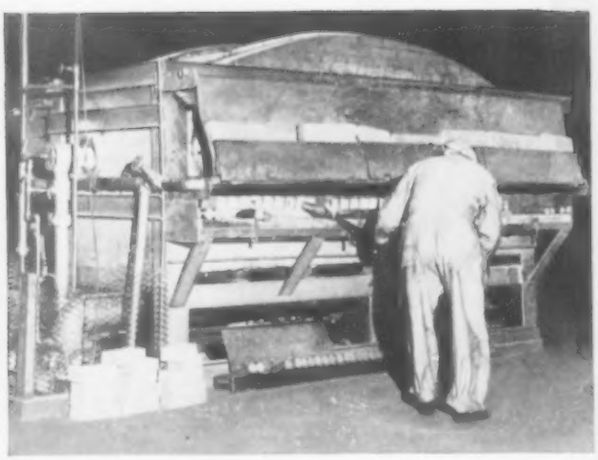


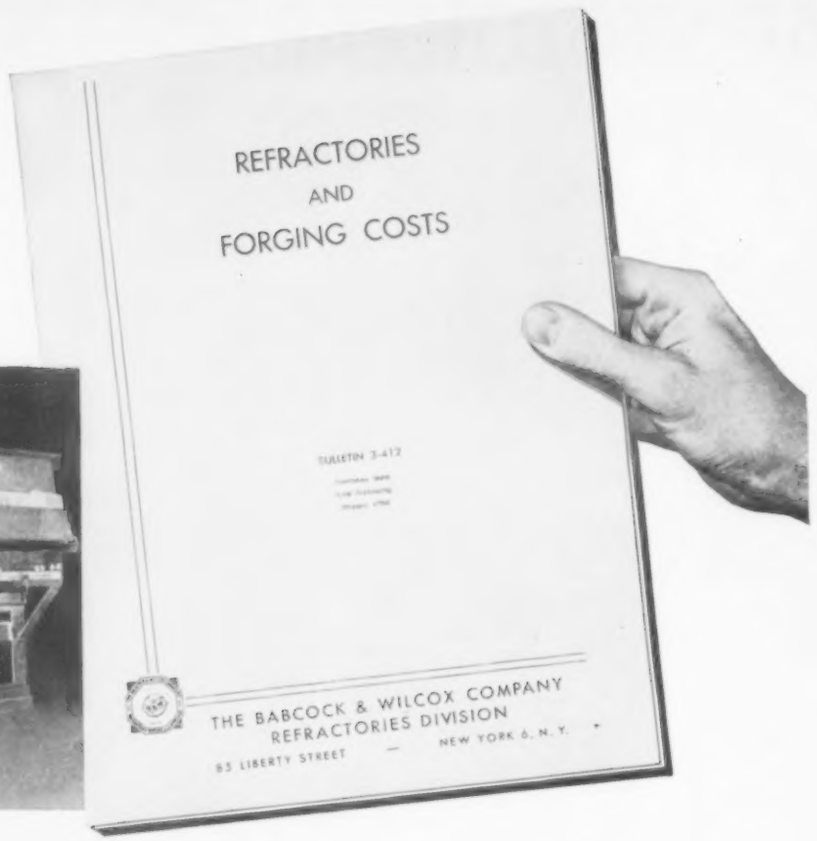
AIR BLAST breakers for metal-clad switchgear units are rated 6.9 and 13.8 kv, 250,000 or 500,000 kva, 1200 and 2000 amperes.

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

Power, Electrical, Processing Equipment for Iron and Steel





FORGING FURNACE OUTPUT

Increased 40%

A new bulletin, available to you on request, provides facts and figures which may well help you achieve significant savings in producing forgings by reducing costs of furnace operation.

IT TELLS HOW:

- **The cost of producing forgings has been reduced by as much as $2.27 per ton**
- **Production per sq. ft. of hearth area has been increased up to 40%**
- **Fuel consumption — down 30% to 75%**
- **Heating up time — reduced by as much as 83%**
- **You may get up to 300% longer service life from forge furnace linings**

It tells *why* these savings are possible . . . through the use of B&W Insulating Firebrick.

Write today for your copy of BULLETIN 3-412

R-328

B&W REFRACTORIES PRODUCTS

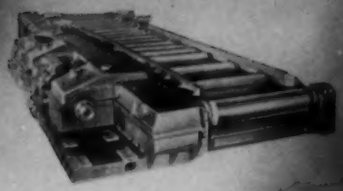
B&W 80 FIREBRICK • B&W JUNIOR FIREBRICK
B&W 80 GLASS TANK BLOCKS • B&W INSULATING FIREBRICK
B&W REFRACTORY CASTABLES, PLASTICS AND MORTARS

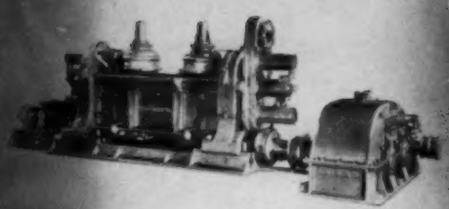
•

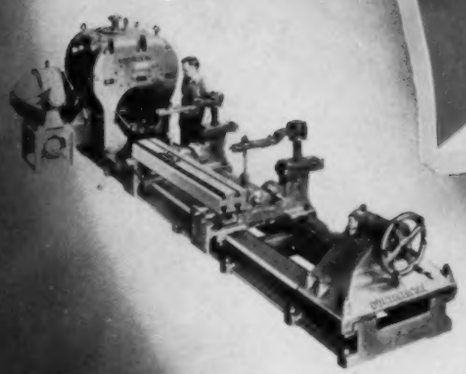
OTHER B&W PRODUCTS

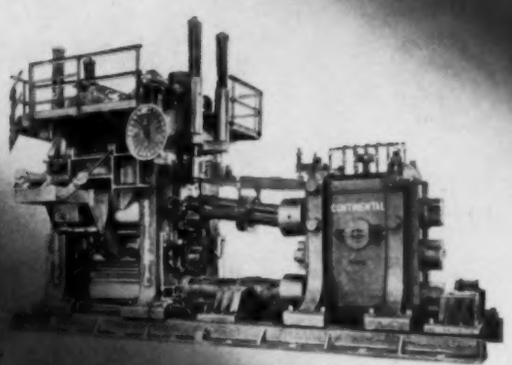
Stationary & Marine Boilers and Component Equipment
Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers
Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

BABCOCK & WILCOX
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: AUGUSTA, GA.





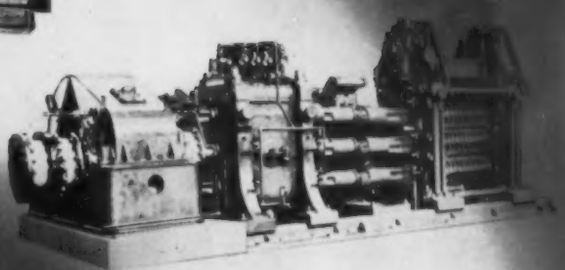




Continental

your logical source for

ROLLING MILLS AND EQUIPMENT



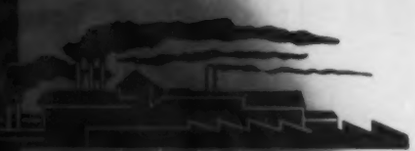
Continental

Continental

FOUNDRY & MACHINE CO.

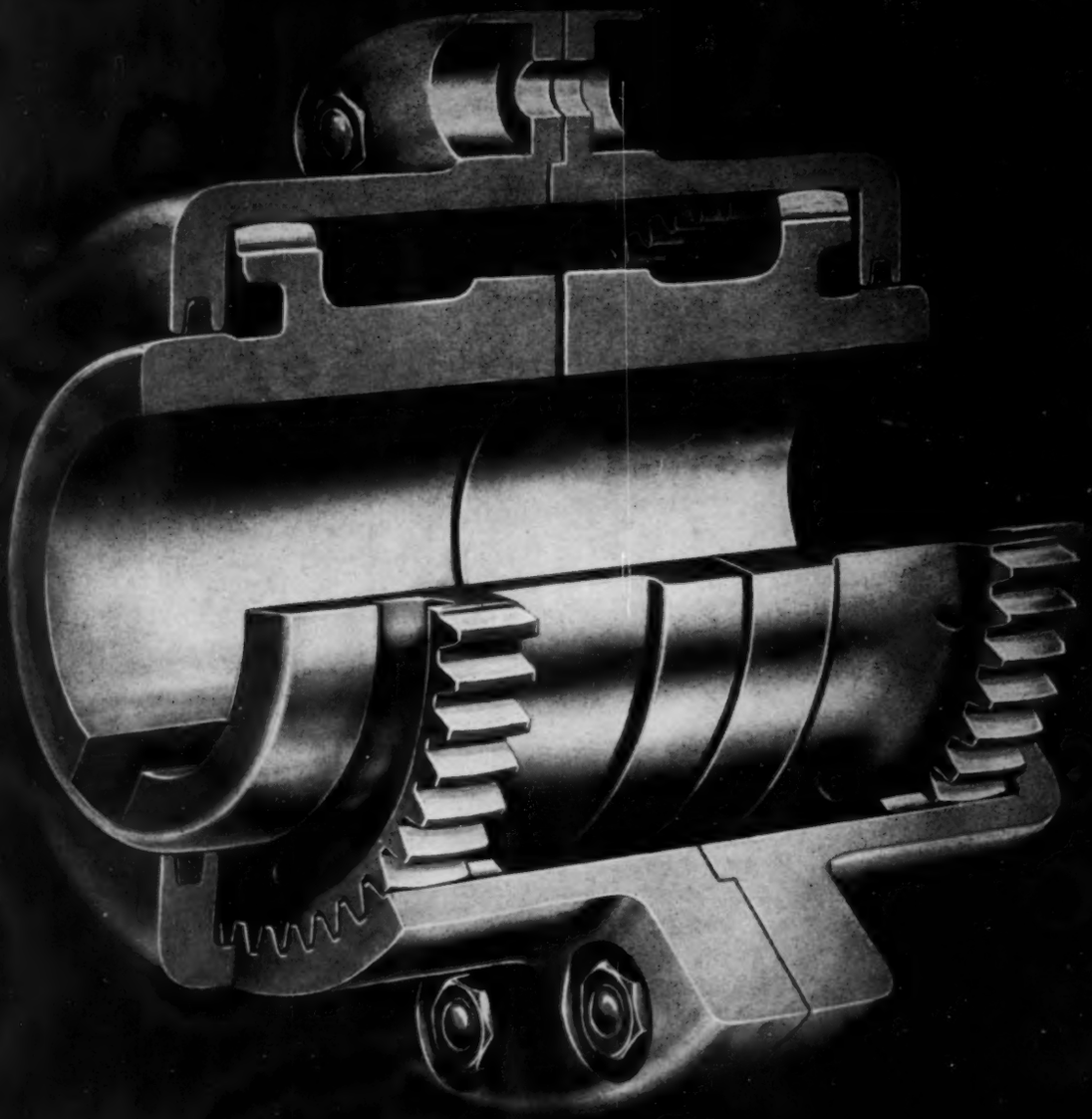
CHICAGO • PITTSBURGH

Plants at East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.



Industry's Headquarters for
Rolling Mills and Equipment

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

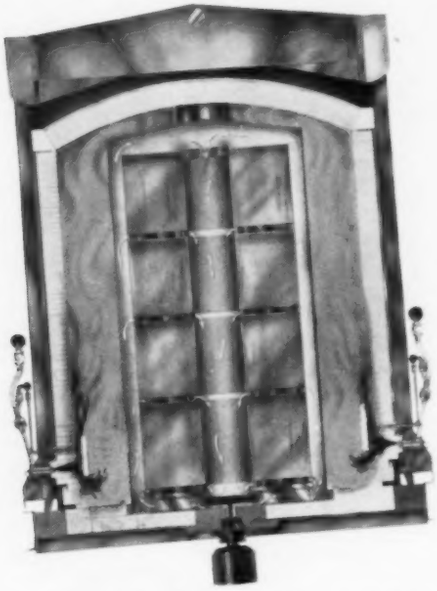
FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

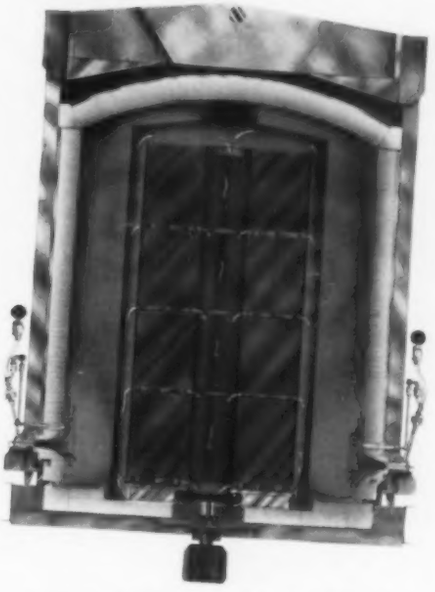
WOODBERRY, BALTIMORE, MD.

▶ **Quality controlled products**
▶ **Increased production**
▶ **Reduced fuel costs**

. . . Features of F. E. I.'s Patented Combustion System



Cross sectional view of F.E.I. patented combustion system during furnace heating cycle.



Cross sectional view of F.E.I. patented combustion system during soaking period.

The F. E. I. patented combustion system provides uniform top and bottom temperatures by causing a double pass of the products of combustion around the inner covers before leaving the furnace, consequently eliminating the possibility of localized overheating. The F. E. I. system is completely automatic, providing maximum fuel burning capacity for high production demands, but at the same time permitting high turn down ratios for extended soaking periods.

The F. E. I. combustion system utilizes with equal efficiency the following types of gas: natural, coke oven, butane, oil refinery, clean producer and clean blast furnace.

F.E.I.

FURNACE ENGINEERS, *Inc.*

Representation in all Foreign Countries.

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.

Specify Vaportight *lighting* PYLETS

for *added* protection

For any indoor or outdoor location subjected to heavy concentrations of non-flammable vapors, gases, dusts or moisture, Pyle supplies a complete line of the highest quality industrial lighting fixtures delivering dependable and efficient illumination. Under these conditions vaportight lighting Pylets have an exceptionally long service life due to their heavy duty construction and especially efficient sealing features.

Bases are available in galvanized cast iron, aluminum alloy and bronze. Receptacles in porcelain and heavy duty molded bakelite. The bases have a large wiring chamber which remains vaportight even though the glass globe is broken or removed. The heavy guards, with or without shields, snap into a taper on the base and may be turned and locked in any position.

The superlative Pylet line for lamps from 10 to 200 watts includes a complete selection of hub arrangements, with or without a switch; varied types for conduit, outlet box, surface, wall and handrail mounting; single, two and three gang fixtures; four reflector styles; portable hand lamps; and midget fixtures for 10 watt lamps. Consult your Pylet catalog 1100 for complete listings.

SINCE 1897

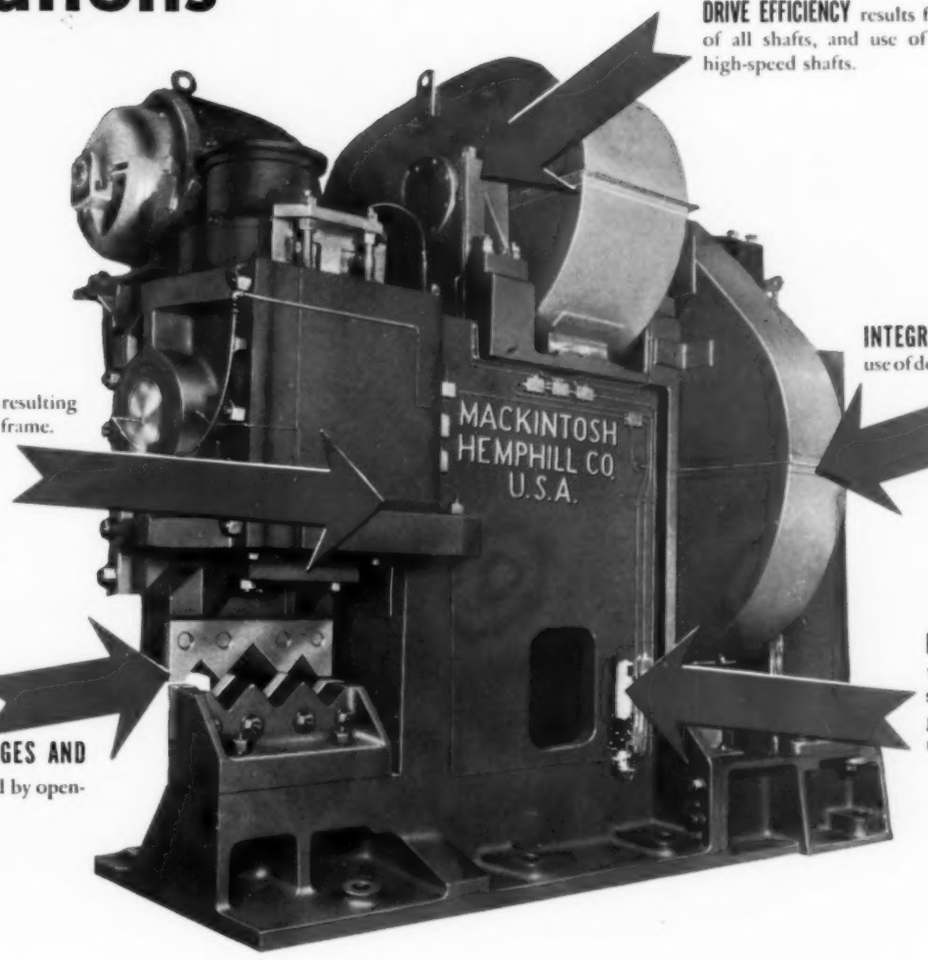
THE PYLE-NATIONAL COMPANY

1370 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

District Offices and Representatives in Principal Cities of the United States. Export Department: International Railways Supply Co., 30 Church St., New York. Canadian Agent: The Holden Co., Ltd., Montreal

PLUGS AND RECEPTACLES • FLOODLIGHTS • TURBO-GENERATORS • CONDUIT FITTINGS • MULTI-VENT AIR DISTRIBUTION

High-speed cut-off shears pace production in continuous forging operations



DRIVE EFFICIENCY results from outboard support of all shafts, and use of Timken bearings on high-speed shafts.

INTEGRAL POWER assured by use of double-helical gear train.

OVERLOAD CAPACITY resulting from heavy cast steel frame.

POSITIVE LUBRICATION with automatic pressure system for bearings, and gearing in enclosed oil-tite case.

RAPID KNIFE CHANGES AND ADJUSTMENT facilitated by open-throat construction.

Designed to prevent lags in the cut-off operation in modern high-speed forging practice, Mackintosh-Hemphill Shears embody the essential features for maintaining continuous production cycles.

Manufactured in six sizes, with capacities ranging from 150 to 1250 tons, Mackintosh-Hemphill Shears can be operator-regulated to conform to the cut-off requirements of automotive and industrial forge shops, and cropping and dividing operations in continuous bar and billet mills.

The high production rate and all-'round flexibility of Mackintosh-Hemphill Shears result from these important advantages—

(a) Overload Capacity (b) Drive Efficiency (c) Integral Power (d) Rapid Knife Changes and Adjustment (e) Positive Lubrication

Whenever cut-off operations must be geared to high-speed forge shop or continuous bar mill practice you'll find that Mackintosh-Hemphill Shears can set the production pace.

MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PA.

Makers of the Rolls with the Red Wabblers

OTHER MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: ROLLS . . . STEEL AND SPECIAL ALLOY CASTINGS . . . COMPLETELY INTEGRATED STRIP MILLS . . . HEAVY DUTY ENGINE LATHES . . . THE NEW MACKINTOSH-ABRAMSEN STRAIGHTENERS . . . IMPROVED JOHNSTON PATENTED CORRUGATED CINDER POTS AND SLAG HANDLING EQUIPMENT . . . SHAPE STRAIGHTENERS . . . SHEARS . . . LEVELLERS.

Would You Like 100 Tireless Hand·Chippers For Your Billet·Shed?

IT'S A MAN·KILLING JOB . . .

LET THE BILLETEER DO IT...

One hand chipper can remove a 12" chip in 60 seconds of ear-splitting, grueling work, whereas . . .

A Bonnot Billeteer operator removes a 12" chip in 2 seconds, as the 45-ton machine responds to his finger-tip control. Electric and hydraulic power activates the carriage, roll-table, chucking, turn-over, feed and turnout units. There's practically NO OPERATOR FATIGUE—no let-up in the steady output.

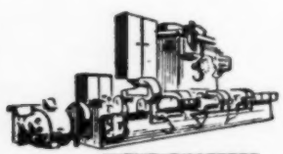
Safety-wise, a recent survey revealed that in 490,000 Billeteer hours of operation, only one man was involved in a disabling accident—A TRULY-TERRIFIC BILLET-SHED SAFETY RECORD.

MEN LIKE TO OPERATE BONNOT BILLETEERS. They decrease employee turnover in your billet-shed and boost efficiency and output.

Write today for complete information. A Bonnot engineer will give your inquiry his personal attention.

Engineered for Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER

ALSO MANUFACTURERS OF SAWING • CHARGING • REVERSING & MANG EQUIPMENT

You can depend

ON . . .

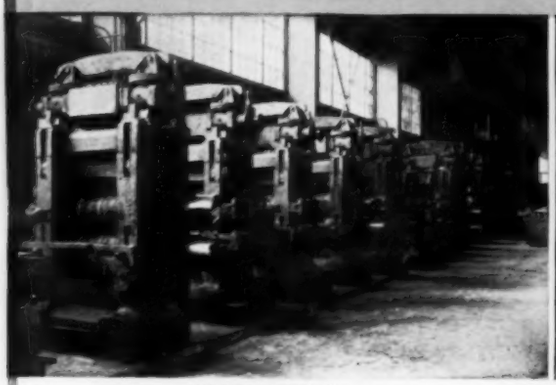
"OPERATIONAL EXPERIENCE"

FOR ALL

LEWIS PRODUCTS . . . . . .

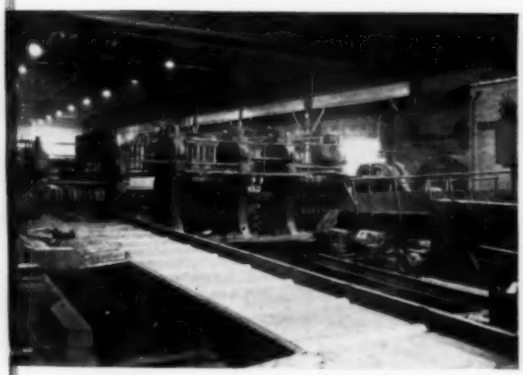
The design-engineer of rolling mill equipment should know rolling practices and problems from A to Z. It's the *operational experience* Lewis engineers possess that determines the design of Lewis Rolling Mills and related machinery ... Results—Simplicity, Productivity and Economy of maintenance.

We welcome the opportunity to discuss ways and means of increasing your capacity and profits.

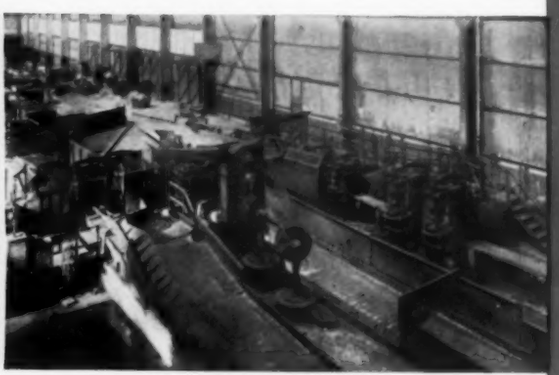


Setup Stands for LEWIS 17 Stand Rod Mill installation

LEWIS 3-High Jump Mill and Tables

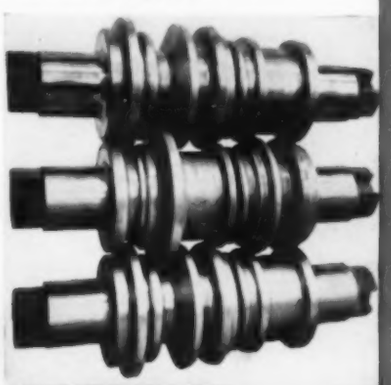


LEWIS Bar and Structural Mill Stand



LEWIS 17 Stand Rod Mill view at finishing end

LEWIS Superior "X" Rolls



LEWIS

ROLLING MILL EQUIPMENT

LEWIS FOUNDRY & MACHINE

Division of Blaw-Knox Co., Pittsburgh, Pa.

Designers and Builders of Rolls and Rolling Mill Equipment

BEDS — Cooling

BLANKS — Gear • Pinion

BOXES — Coupling

CASTINGS — Rolling Mill Furnace

COILERS — Ferrous and Nonferrous Strip

GEAR DRIVES

GEARS AND PINIONS — Bevel • Double Helical • Single Helical • Speed Reduction • Spur

HOUSING PINION — Rolling Mill

LATHES — Roll Turning

LEVELERS — Roller for Plate and Sheet

MACHINERY — Special • Flaking Mill • Rolling Mill

MACHINES — Pickling

MANIPULATORS — Rolling Mill

MILLS — Aluminum Foil • Bar • Billet and Blooming • Brass and Copper • Cold Rolling • Continuous • Edging • Four-High • Single Stand • Reversing and Tandem • Merchant • Plate Rolling • Precision • Sheet and Strip • Slabbing • Three-High • Tin Plate • Universal • Wire • Zinc Strip • Roughing and Finishing

REELS — Tension

ROLL RAGGING ATTACHMENTS

ROLL POLISHERS

ROLLS — Alloy Iron • Chilled Iron • Sand and Chilled Iron • Steel

SAWS — Hot and Cold

SCREWDOWNS — Motor Operated • Hand Operated

SHEARS — Alligator • Bar • Billet • Bloom • Continuous Automatic • Sheet Mill • Gate or Guillotine • Lever • Plate • Power Driven • Scrap • Vertical

STRAIGHTENERS — Angle • Bar • Rails and Shapes

TABLES — Blooming Mill • Rolling Mill Feed • Transfer for Mills

DEPENDABLE POWER

Save TIME...SPACE...MONEY...with

Battery Electric Trucks and

EXIDE-IRONCLAD BATTERIES

You gain in many ways when your materials are handled the efficient, modern way—in UNIT LOADS by Battery Electric Trucks. Goods move faster and in greater volume. More storage space can be utilized by higher tiering. Handling costs are reduced . . . often as much as 50%. And when the batteries are Exide-Ironclads, you can count on minimum power costs and full shift availability.

EXIDE-IRONCLAD BATTERIES are DIFFERENT . . . in construction . . . in performance. They have ALL FOUR of the characteristics a storage battery must have to assure maximum performance from battery electric industrial trucks—high power ability, high electrical efficiency, ruggedness, and a long life with minimum maintenance. This combination assures years of day-in, day-out service with dependability, safety and economy.

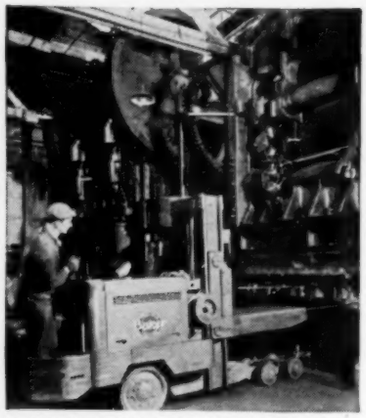
Write for further particulars and FREE copy of Exide-Ironclad Topics, which contains latest developments in materials handling and shows actual case histories.

1888 . . . Dependable Batteries for 61 Years . . . 1949

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32

Exide Batteries of Canada, Limited, Toronto

BAKER FORK TRUCK



BAKER HIGH LIFT PLATFORM TRUCK

"Exide-Ironclad" *Reg. Trade-mark U.S. Pat. Off.*

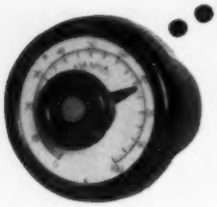
50th birthday of the company whose products you know by the trade-mark: TIMKEN

SINCE 1899 THE TIMKEN ROLLER BEARING COMPANY HAS BEEN HELPING AMERICAN INDUSTRY GET THE MOST FOR ITS MONEY

NOBODY likes to buy a "pig in a poke". In America you don't have to. You're protected by trade-marks like "TIMKEN".

Registered as a trade-mark in the United States Patent Office, "TIMKEN" identifies products made by The Timken Roller Bearing Company: Timken tapered roller bearings, Timken alloy steels and seamless tubing and Timken removable rock bits.

Experience over the years has shown Timken products to be the finest in their respective fields. And many thousands of men and women are working hard to keep them that way. No wonder it has become a habit throughout industry to look for the trade-mark "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".



TRANSMITTER

Operate VALVES, THROTTLES, MACHINES, VARIABLE DRIVES . . .

Up to 1,000 FEET AWAY

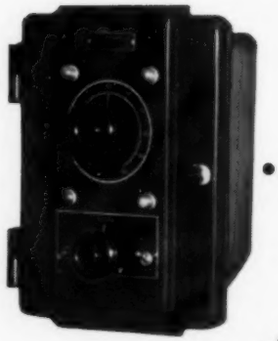
SIMPLY, ACCURATELY, WITH THE ASKANIA ELECTRONIC SERVO SYSTEM

Consider the advantages of operating mechanisms from a remote point up to one thousand feet away — for equipment in a dangerous, inaccessible or inconvenient location. A central control system for several of the receivers is possible. Precise operation is assured by the system's accuracy of ¼ of 1%.

Operating on a standard 115 volt a-c current, the standard receiver shown in the illustration can offer torques up to 220 pound-inches. With the addition of a hydraulic cylinder, torques as high as 7,500 pound-inches can be achieved.

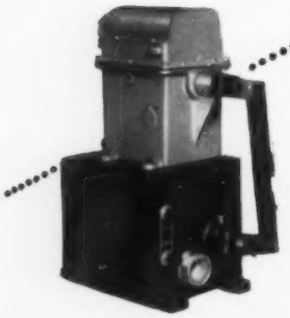
Almost any combination of the three units can be devised to permit multiple networks of transmitters and receivers.

All components of the system are constructed for heavy duty, rugged industrial operation. Dust-proof, cast metal cases withstand shocks, vibration and corrosion. All circuits and tubes can be reached easily without impairing the operation or original installation. Only two electrical supply line connections are needed for the entire system. Write for full information.



AMPLIFIER

RECEIVER



Accurate, powerful, simple remote control of dampers, valves, gates, throttles, pumps, machine tools, variable speed settings . . . can be achieved with a combination of the Askania Electronic System components shown in the illustration. A position signal selected at the transmitter or amplifier either manually or by means of cams, gears, or linkages causes the receiver crank arm to change position over a 90 degree arc.

ASKANIA Controls

Send for Bulletin 138 A

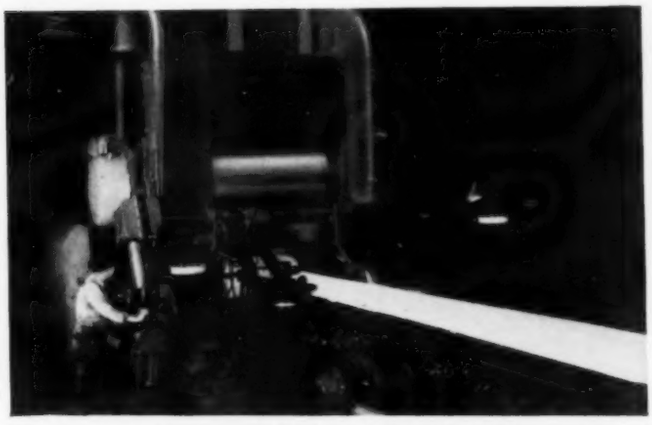
ASKANIA REGULATOR COMPANY

A Subsidiary of General Precision Equipment Corporation

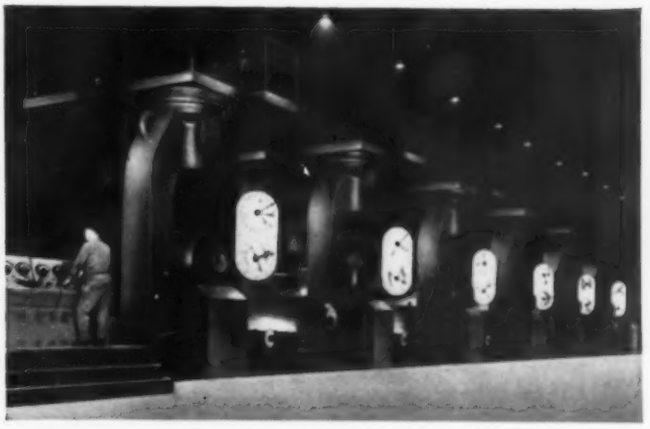
240 EAST ONTARIO STREET CHICAGO 11, ILLINOIS

Torrington Roll Neck Bearings perform reliably all along the line in Carnegie-Illinois hot strip mill

In the No. 2 rougher of the Gary Sheet and Tin Mill, Torrington Roll Neck Bearings assure reliable performance under tremendous radial and thrust loads.



The No. 4 roughing stands also benefit from the high capacity and smooth operation of Torrington Tapered Roller Bearings.

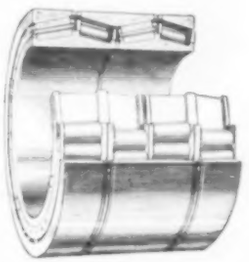


The finishing touch is put on the strip in these stands, with work rolls operating at high speed on Torrington Bearings.

At the Gary Sheet and Tin Mill of Carnegie-Illinois Steel Corp., Torrington Roll Neck Bearings bring many operating advantages in the 80" hot strip mill.

For reliability, they provide tremendous capacity with a reduced cross-section that allows larger roll necks. High productive efficiency, too, results from the smooth operation and rapid acceleration possible with Torrington Bearings. And maintenance is minimized by their efficient lubrication and long service life.

Equip your rolling mills for reliable, economical performance with Torrington 4-row Tapered Roller Bearings. Our engineers are always glad to help with design and application problems. Write us today. THE TORRINGTON COMPANY, South Bend 21, Ind., or Torrington, Conn. District offices and distributors in principal cities of United States and Canada.



TORRINGTON TAPERED ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Straight Roller Needle • Ball • Needle Rollers

Here's How to Erase Smoke Troubles

VIOLATION OF SMOKE ORDINANCE

LOSS OF FUEL ECONOMY

BAD COMMUNITY RELATIONS

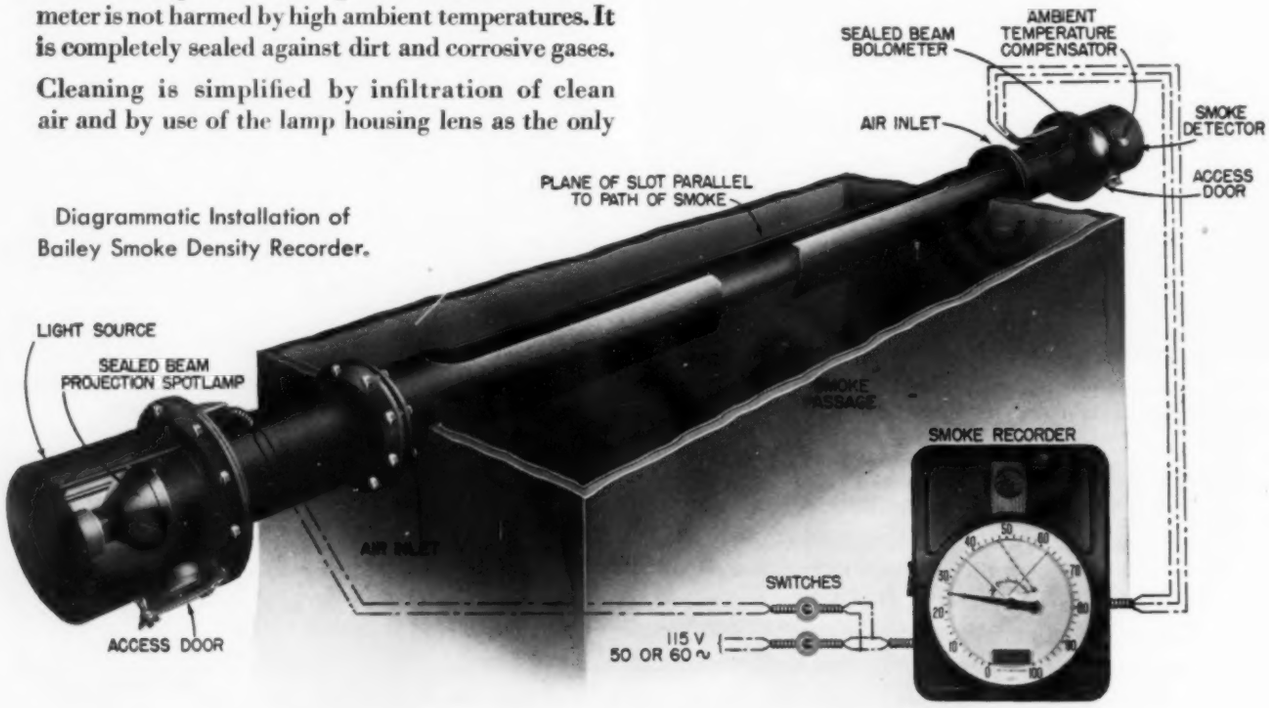
★ One of your first steps in erasing these troubles which result from excessive smoke, should be the installation of a Bailey Smoke Density Recorder. This 24-hour recorder is not an ordinary photo-cell instrument. Instead it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing.

In using this simple, unique smoke detector, you do not have to provide cooling devices since the Bolometer is not harmed by high ambient temperatures. It is completely sealed against dirt and corrosive gases.

Cleaning is simplified by infiltration of clean air and by use of the lamp housing lens as the only window between the Bolometer and the gas passage.

It's easy to secure and maintain alignment of the sealed beam light source with the Bolometer since they are mounted at opposite ends of a slotted pipe which extends across the smoke passage.

For complete information on how you can profitably use this unique instrument to erase your smoke troubles, ask for Bulletin 211, "Bailey Smoke Density Recorder".



Diagrammatic Installation of Bailey Smoke Density Recorder.

G-29

BAILEY METER COMPANY

1047 IVANHOE ROAD, CLEVELAND 10, OHIO • BRANCH OFFICES IN PRINCIPAL CITIES

BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

Let Bailey Smoke Density Recorders Watch Your Stacks

PARALLOY

REGISTERED TRADE MARK

A name of Quality in

- PINCH ROLLS
- COILER ROLLS
- TENSION ROLLS
- STEEL MILL ROLLS

NO SCRATCHING OR GALLING

500-600-BRINNEL

MORE TONS PER PASS

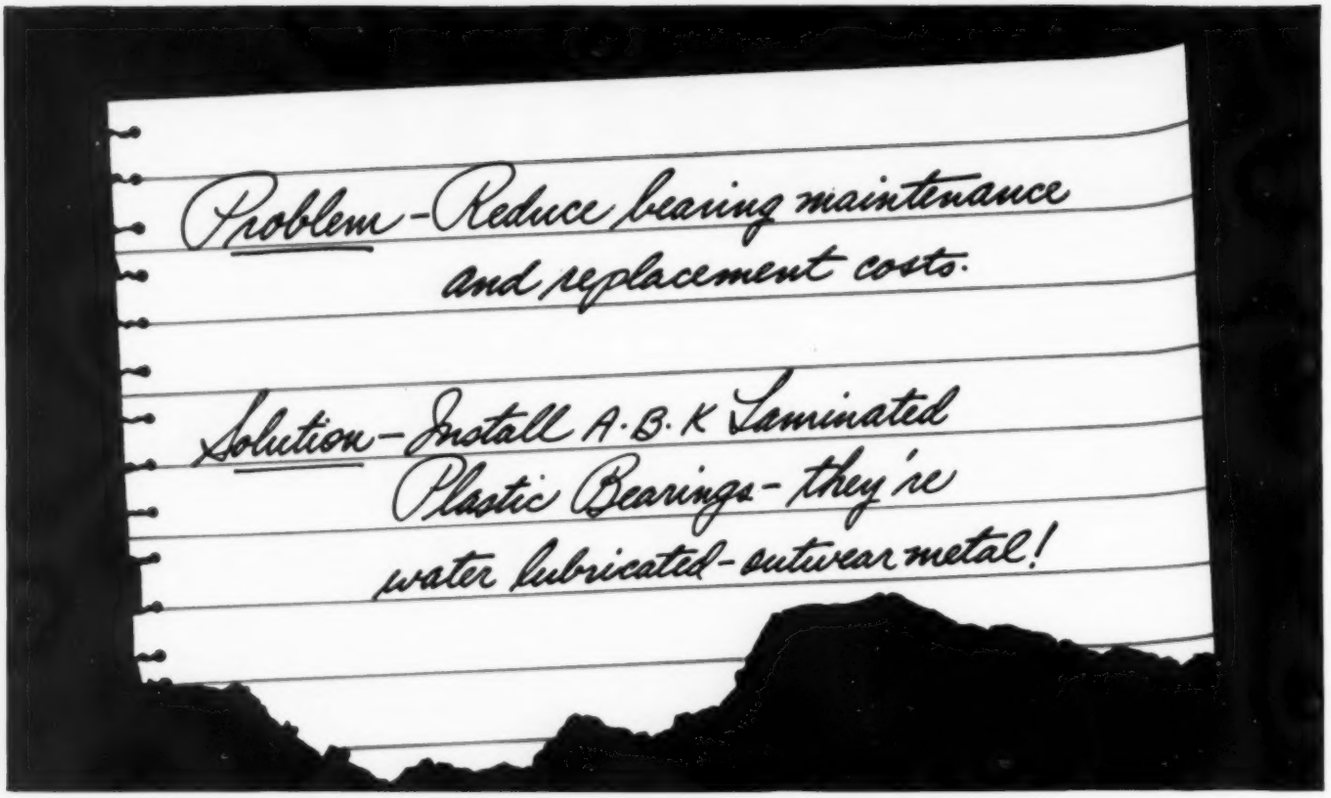
OTHER PRODUCTS

HYDRAULIC SLAB AND BILLET PILERS
STRIP AND SHEET OILING EQUIPMENT
SHEET SCRUBBER AND CLEANING LINES
HOT SAWS—ROCKING AND SLIDE TYPES
HOT BEDS—COOLING BEDS—TRANSFERS
BILLET EJECTORS—PINCH ROLL STANDS
SLITTERS—SPECIAL SHEARS AND GAUGES
TILTING TABLES—TRAVELING AND LIFTING TABLES
CONTINUOUS PICKLING LINES—ROLLER LEVELLERS
FURNACE CHARGING EQUIPMENT—FURNACE PUSHERS
STRIP STEEL COILERS AND REELS—SCRAP BALLERS
RAILROAD SPIKE FORMING MACHINES— ROLL LATHES
SHEET GALVANIZING LINES—WIRE PATENTING FRAMES
STRETCHER LEVELLERS—ANGLE AND SHAPE STRAIGHTENERS
ROLLING MILL TABLES—GEAR AND INDIVIDUAL MOTOR TYPES
MACHINERY BUILT TO CUSTOMER'S DESIGN AND DETAIL DRAWINGS

The Youngstown Foundry & Machine Co.

Youngstown, Ohio

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY


Problem - Reduce bearing maintenance and replacement costs.
Solution - Install A·B·K Laminated Plastic Bearings - they're water lubricated - outwear metal!

● When A-B-K Laminated Plastic Bearings replace conventional steel mill bearings, savings begin *immediately*.

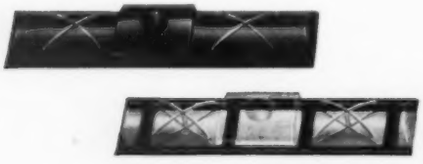
First, cost of lubricating oil is eliminated entirely. A-B-K bearings are successfully lubricated with *water*.

Second, A-B-K bearings cut power consumption from the start.

Third, A-B-K bearings hold gauge longer—require fewer adjustments—reduce costly shutdowns.

Fourth, A-B-K Laminated Plastic Bearings actually outwear metallic bearings. The material in these bearings is exceptionally tough and slow-wearing. It will not distort under shock and is highly heat-resistant. Actually polishes—never scores—the shaft!

Add up these advantages of A-B-K Laminated Plastic Bearings in terms of dollars and cents *saved*. An A-B-K representative, backed by the vast research and engineering facilities of our organization, will be glad to tell you how A-B-K bearings can cut costs on specific applications in your mill. Write for a consultation.



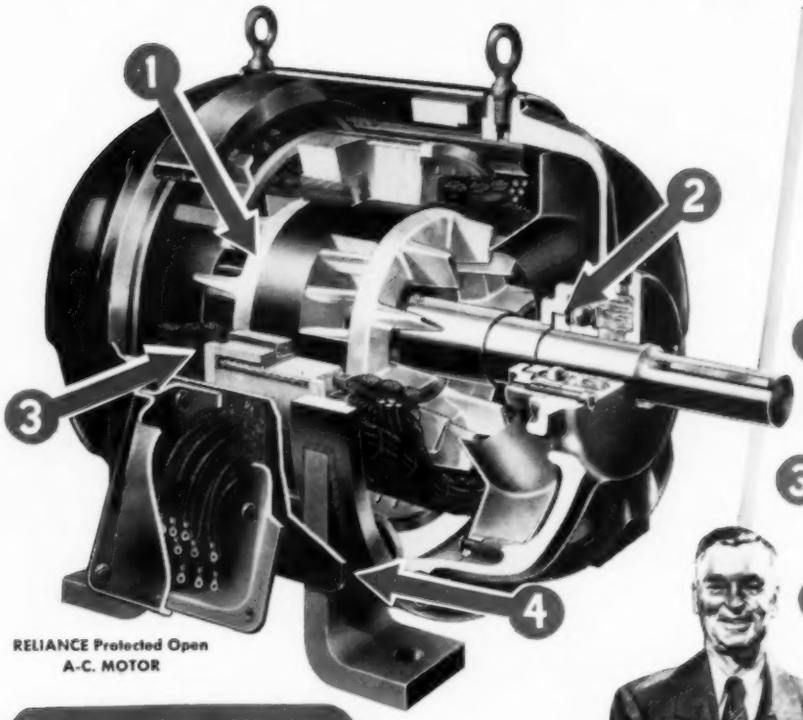
Above: A-B-K slipper bearing, with phantom view showing patented reinforced edge.
Right: A-B-K roller neck bearing with separate collar.

A·B·K
Laminated Plastic Bearings

AMERICAN Brake Shoe COMPANY

AMERICAN BRAKEBLOK DIVISION
DETROIT 9, MICHIGAN

WHO SAYS "All Motors are Pretty Much Alike?"



RELIANCE Protected Open A-C. MOTOR

These Four Features *Alone* make RELIANCE the motor for you!

1. **Dynamic Balancing — Precision Fits** — Every motor is dynamically balanced by skilled technicians using latest electronic-principle equipment. Machining of parts to exacting tolerances guarantees precision fits throughout. Result: a smoother-running, longer-lasting motor!
2. **No Lubrication Worries** — Precision Bearing Mounting, with double-shielded ball bearings, assures longer bearing life under all normal conditions, whether overgreased, undergreased or not greased at all. *"You can't grease 'em wrong!"*
3. **Reli-X Insulation** furnishes a new high in the protection of stator windings. Selected materials, exclusive methods and new continuous-sequence applications make this the *unfailing* insulation!
4. **Steel for Strength** — Steel construction, with electrically welded joints, combines maximum strength with minimum weight.

RELIANCE *Precision-Built* MOTORS . . . are made *better* to deliver DEPENDABLE POWER — LONGER!

Reliance has a way of building motors that must be seen to be fully appreciated. Any time we can take a motor user through the modern plants where Reliance *Precision-Built* Motors are made, we can be reasonably sure of another good Reliance customer. We would be delighted to have you make this visit. But if it isn't practical, call in your nearest Reliance representative and *see* the convincing facts he can show you on the precision methods that produce these truly superior motors.

HOW TO SELECT THE RIGHT MOTOR

Here's a book which digests all the information you should have in selecting the motor that's just right for any job. New torque and current standards recently adopted by the National Electrical Manufacturers Association for A-c. motors are tabulated and explained. And these are further supplemented by more detailed performance data on Reliance *Precision-Built* Motors. Write today for this important new Motor Data Bulletin, B-2101.

Sales Representatives in Principal Cities

RELIANCE ELECTRIC AND ENGINEERING CO.

"Motor-Drive is More Than Power" • 1084 Ivanhoe Road, Cleveland 10, Ohio

YOUR CHOICE

CHOICE #1

Immersion Tube

Measuring bath temperature with the air-purged immersion tube.

. . . for quick, accurate, economical Bath Temperature Measurement

BOTH of these precision sensing devices are proved by widespread acceptance throughout open hearth operations.

Users report improved steel quality, reduction of "skulls" and "stool stickers," lowered fuel consumption and prolonged furnace life . . . all important benefits of proper bath temperature measurement.

The selection of measuring method is a matter of personal preference . . . some operators like the immersion tube, others like the platinum thermocouple. Take *your choice!* Both use the famous *ElectroniK* Potentiometer.

Call in your local Brown engineer for detailed information . . . he is as near as your phone.

CHOICE #2

Platinum Thermocouple

Measuring bath temperature with the platinum thermocouple.

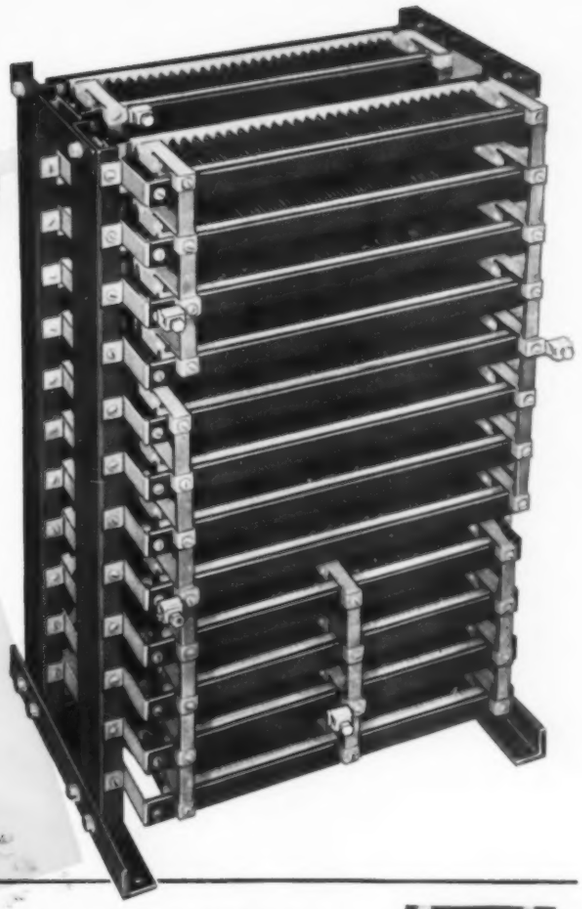
MINNEAPOLIS-HONEYWELL REGULATOR CO.
BROWN INSTRUMENTS DIVISION
4464 Wayne Ave., Philadelphia 44, Pa.

Offices in principal cities of the United States, Canada and throughout the world

MINNEAPOLIS Honeywell — *Advanced Instrumentation* FOR METAL PRODUCING — BROWN INSTRUMENTS

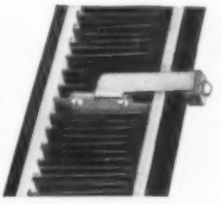
adjustable EDGEREST RESISTORS

for Mill Duty applications where uninterrupted production is vital and service is severe



Edgerest resistor banks are constructed from units of various lengths, gauges of ribbon, and kinds of metal to provide a wide range of ratings. Ventilated enclosures are available.

Only one style of terminal clamp used for all connectors . . . supported by porcelain blocks to avoid strain on the ribbon . . . easily placed in any position, permitting close adjustment of resistance values.



Mill Type Control with Ventilated Resistor

NON-BREAKABLE • unaffected by vibration.

CORROSION-RESISTANT • stainless steel and nichrome ribbon.

EDGEREST DESIGN • ribbon bent on flat to avoid reduction in cross-section, eliminate stress and provide rigid support in mounting.

TERMINALS • clamp type, supported at both sides of frame to eliminate strain on ribbon.

ADJUSTABLE • terminal clamps can be placed on any loop of ribbon, permitting close adjustment to suit actual operating conditions.

EFFICIENT • ribbon suspended with no obstruction to retard air flow. Stacks provide chimney effect. Minimum radiation to metal supports.

MOUNTING • individual units are removable from frame without disassembly.

SQUARE D COMPANY

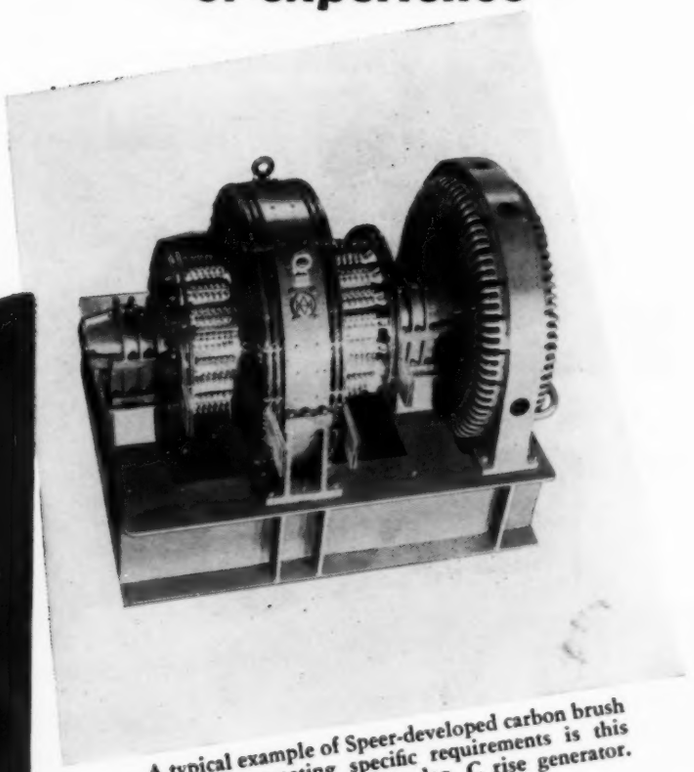
DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

Speer carbon brushes

REFLECT

50 years of experience



A typical example of Speer-developed carbon brush assemblies meeting specific requirements is this 15,000 ampere, 6 volt, 40 deg. C rise generator.

Reflected in almost every important carbon brush advancement since the first, is Speer Carbon Company's never-ending search for better commutation. Major Speer developments include Multiflex and Transert design—brush assemblies for a wide range of jobs.

Speer's half-century of experience is available for the study of your commutating problems.

Speer

CARBON COMPANY
ST. MARYS, PENNA.

brushes • contacts • welding electrodes • graphite anodes • rheostat discs • packing rings • carbon parts

CHICAGO • CLEVELAND • DETROIT • MILWAUKEE • NEW YORK • PITTSBURGH

Quik Quiz on CONDULETS

Questions and answers
regarding the backbone of
an electrical wiring installation

Type C
Obround Condulet
Broken-away view showing (1) tapered threads, and (2) the Wedgenut fastener

Question. When were CONDULETS first made?

Answer. In 1906 Crouse-Hinds Company introduced CONDULETS to the electrical wiring industry. CONDULETS represented an entirely new idea in conduit outlets, totally unlike the outlet boxes and fittings previously made. CONDULETS were destined to revolutionize electrical conduit installation practice.

Q. How did the word "CONDULET" originate?

A. Crouse-Hinds new conduit outlets needed a name so the word "CONDULET" was coined, a contraction of "conduit" and "outlet." It is registered in the U. S. Patent Office and designates a product made only by the Crouse-Hinds Company.

Q. What were the advantages of CONDULETS over previous outlets?

A. The older outlets were both unhandy and unsightly, while the new cast CONDULETS were streamlined, compact outlets that were handy to install and produced a neat appearing job. The oblong body with round ends suggested the name "Obround", which was applied to the first series of CONDULETS.

Q. Were they like the present Obround CONDULET?

A. There have been important refinements, but the basic design remains the same. The most notable improvement was the Crouse-Hinds Wedgenut fastener which provides a handy way to firmly attach the covers.

Q. How many types are now in the Obround Series?

A. Forty-nine types. Sizes to fit ½" to 6" conduits, with a wide selection of interchangeable covers and wiring devices.

Q. What other CONDULETS have been added to the line?

A. Obround CONDULETS were so well received by the electrical trade that a variety of other types followed in rapid succession. In fact, the CONDULET line has grown far beyond the original concept and now includes, besides the items needed for the usual conduit installations, a complete line of explosion-proof and dust-tight CONDULETS for use in industries where explosive gases or dust require special electrical safeguards.

Q. Why are all the threads in CONDULET hubs taper tapped?

A. Because all conduit threads are tapered and it makes an imperfect job if a tapered thread is screwed into a straight threaded hole. When using CONDULETS, the threads on the conduit firmly engage every thread in the hub, because both are tapered. This makes a rigid joint which will not loosen under vibration and also assures permanent ground continuity. Taper tapping is an important Crouse-Hinds feature.

Q. What about CONDULET quality?

A. CONDULETS have always been noted for the highest quality. They are scientifically designed in Crouse-Hinds Engineering Department and carefully manufactured in a modern factory by skilled craftsmen from the finest material obtainable. Crouse-Hinds operates four separate laboratories where trained technicians assist in the development of new products and maintain a constant control over the quality of CONDULETS.

Q. How many CONDULETS are there today?

A. More than 15,000 items constitute the present CONDULET line. Conduit installations in all parts of the world are equipped with CONDULETS.

Q. WHERE CAN I BUY CONDULETS?

A. From the beginning it has been the Crouse-Hinds policy to have . . . **A Nationwide Distribution through Electrical Wholesalers.** There is one near you.

CONDULETS
FLOODLIGHTS
TRAFFIC SIGNALS
AIRPORT LIGHTING

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

Offices: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit Houston — Indianapolis — Kansas City — Los Angeles — Milwaukee — Minneapolis — New York Philadelphia — Pittsburgh — Portland, Ore. — San Francisco — Seattle — St. Louis — Washington. *Resident Representatives:* Albany — Atlanta — Baltimore — Charlotte — New Orleans — Richmond, Va. CROUSE-HINDS COMPANY OF CANADA, LTD., *Main Office and Plant:* TORONTO, ONT.

A Nationwide Distribution Through Electrical Wholesalers

MORGOIL
ROLL NECK BEARINGS

MORGAN
WORCESTER
Rolling Mills - Wire Mills - Gas Producer Machines - Regenerative Furnace Control

Years of use have proven the value of MORGOILS with self-aligning *roller* thrust bearings for 21" and upwards.

Now the same principle has been extended to MORGOIL bearings 18" and less by the use of *ball* thrust. This construction gives exact pass alignment when rolling small sections.

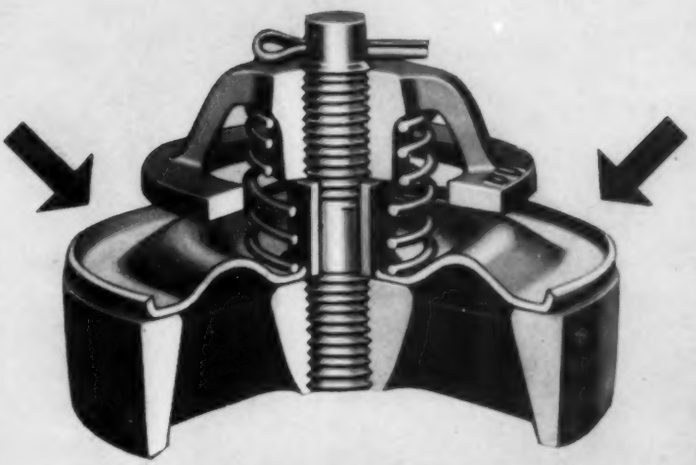
MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

English Representative: International Construction Co.
56 Kingsway, London, W. C. 2, England

MB-10

DURABLA

Valve Member Utilizes Arch Construction For Strength But Can Flex To Adjust To Any Slight Variations In Plane Of Valve Seats.



Valve Member Is Free To Move Around The Guard-Stem Or To Assume Any Angle And Maintains A Seal Which Is Self-Grinding At All Times

PUMP VALVE SERVICE

The patented arch construction Durabla Valve Member* retains sufficient flexibility, despite its great strength, so that the valve-to-seat contact maintains a constant pressure-proof seal. The Valve Seat is rigid, the Valve Member is freely mounted. Hence the free member accommodates itself to wear of the valve parts which may occur in severe service.

Since the Valve Member is freely mounted, a unique feature of Durabla engineering, it can turn about the Guard-Stem and a self-grinding pressure-proof seal is always maintained. Lower maintenance costs; Infrequent need for inspection; Minimum lost time for repairs are all achieved through the use of Durabla "The Valve That Grinds Itself."

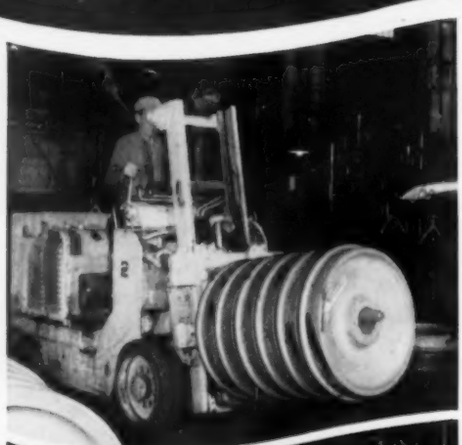
Address DURABLA Engineering Department for Information and Bulletin No. 956

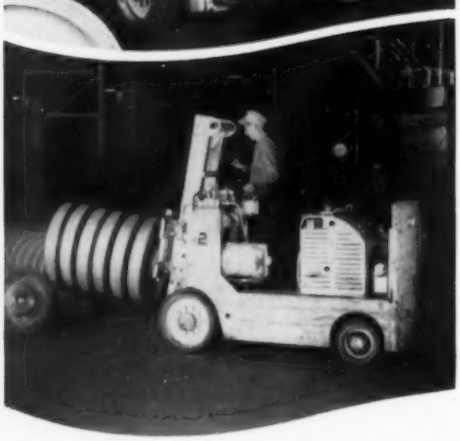
* Patent Numbers 2090486, 2117504

DURABLA MANUFACTURING COMPANY
114 LIBERTY ST. NEW YORK
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO

Handling Car Wheels the SAFE *way with* BAKER TRUCKS—

- cuts handling costs!
- saves time!
- eliminates accidents!
- conserves manpower!





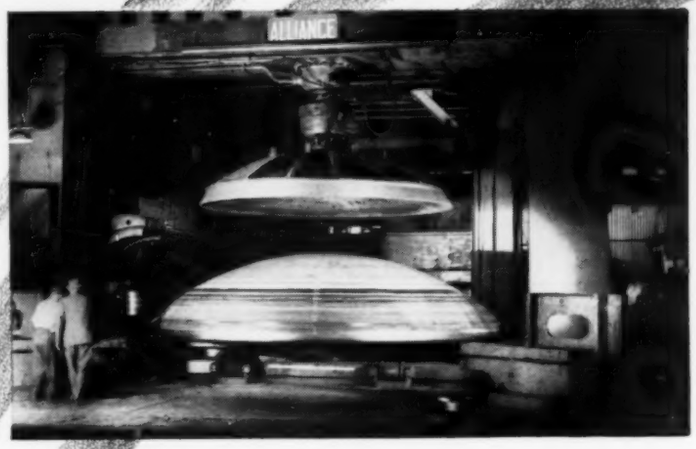
● Handling car wheels manually has always been a hazardous, costly operation. Illustrations show how one wheel manufacturing company has brought about substantial cost savings, at the same time greatly reducing lost time due to accidents, by mechanizing wheel handling with two Baker 6000 lb. Ram Trucks.

The trucks are used to handle wheels in production. Wheels are carried 6 at a time from the forging machines to the wheel turning machines where they are lined up on the floor awaiting the processing operation. When needed, they are transported to the turning machine, and as they are finished they are moved to the shipping floor, where they await loading into gondola cars by means of overhead cranes.

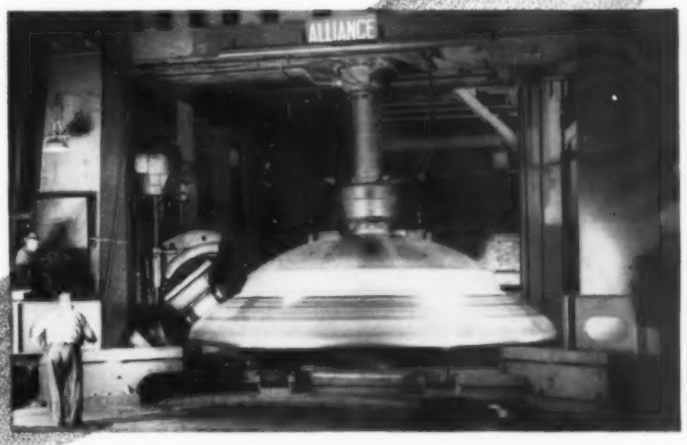
Wheel hauling is but one of many hazardous industrial handling operations made safe by mechanization with Baker Trucks. A Baker Material Handling Engineer is at your service to solve your specific problems.

BAKER INDUSTRIAL TRUCK DIVISION
of The Baker-Raulang Co.
1229 WEST 80th STREET • CLEVELAND, OHIO
In Canada: Railway & Power Engineering Corp., Ltd.

Baker INDUSTRIAL TRUCKS



the WORLD'S LARGEST SPUN HEADS are formed on this machine . . .



built by Alliance
builder of the world's largest cranes

- LADLE CRANES
- GANTRY CRANES
- STRIPPER CRANES
- SOAKING PIT CRANES
- FORGING MANIPULATORS
- OPEN HEARTH CHARGING MACHINES
- SLAB AND BILLET CHARGING MACHINES
- SPECIAL MILL MACHINERY
- STRUCTURAL FABRICATION

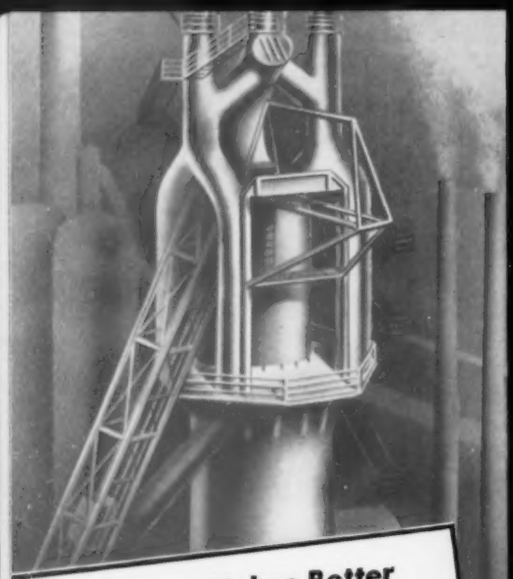
● Lukens Steel Company in Coatesville, Pennsylvania, now forms the world's largest spun metal heads on the huge machine shown above. This 276-inch spinning machine was developed and built by The Alliance Machine Company, in collaboration with Lukens engineers. The holding plunger, shown at the top, while holding and forming the plate, exerts a pressure of 600 tons, and, during spinning and flanging the plate, exerts a pressure of 300 tons. The machine forms heads up to 20′ 6″ in diameter or up to 6½″ in thickness.

This is just one example of the skill and versatility of The Alliance Machine Company in designing and building rugged machines for heavy industrial applications. Let Alliance—World's Largest Builder of the World's Largest Cranes—develop the equipment best suited to your plant operations.

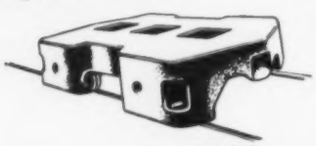
THE ALLIANCE MACHINE CO.

Main Office
ALLIANCE, OHIO

Pittsburgh Office
1099 OLIVER BLDG. PITTSBURGH 22



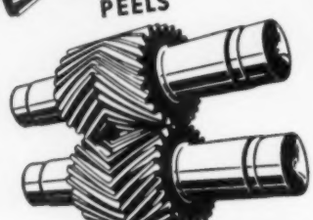
"UNION" Makes Better



INGOT CARS

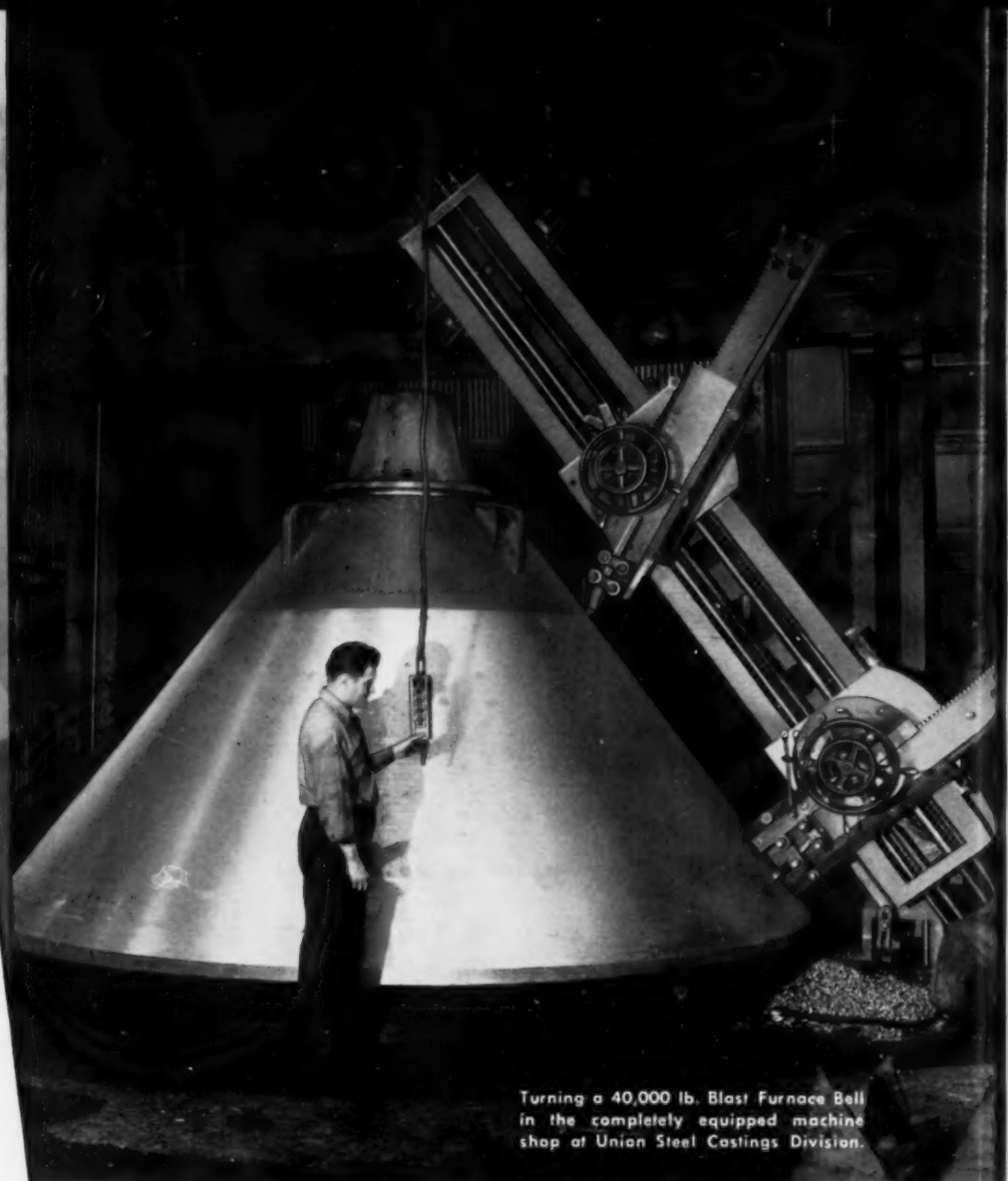
CHARGING BOXES

PEELS



GEARS AND PINIONS

SLAG AND CINDER POTS



Turning a 40,000 lb. Blast Furnace Bell in the completely equipped machine shop at Union Steel Castings Division.

"UNION" CASTS *AND* *MACHINES* BLAST FURNACE BELLS

Here at "Union," special steel formulas have been developed to combat the hot acid gases and abrasive charges associated with blast furnace service. In addition, casting techniques, reflecting many years of foundry background, assure a rigid cone, and special vertical boring mills machine the bell to provide a gas tight seat. Accurate seating is further assured because each bell is thoroughly balanced before it leaves our shop. We'll be glad to quote from your blue prints and specifications.

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX COMPANY . . . PITTSBURGH 22, PA.

One LINK-BELT Plant devoted *Solely* to bringing you better bearings—*Quickly*

"The Home of Good Bearings"—LINK-BELT Dodge Plant
519 North Holmes Avenue, Indianapolis, Indiana

Meeting industry's ever-increasing demands for ball and roller bearings that offer the desired combination of free-rolling action, self-alignment, and long life is no small-sized job.

That's why the entire capacity of Link-Belt's Dodge Plant in Indianapolis is devoted to this important task.

From the receipt of housing castings furnished by sister plant foundries to shipment of finished mounted bearings, alert design engineers, skilled craftsmen and the most modern bearing production machinery work hand-in-hand to turn out the bearings that enable users to TURN SHAFTS EFFICIENTLY.

Cut-away view of Series 200 Ball Bearing Pillow Block

LINK-BELT COMPANY

Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Distributors in Principal Cities

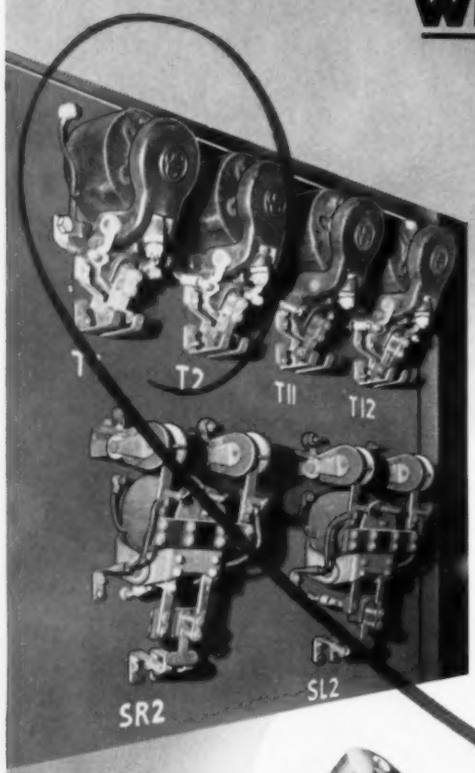
11,387

LINK-BELT

Ball and Roller BEARINGS

Over 25,000,000 OPERATIONS from these CLARK Timing Relays

WITH NO MAINTENANCE!



ONE OPERATION EVERY 3 SECONDS

On January 26, 1947, these 4 CLARK Bulletin 7313 VARI-TIME Relays were installed on a processing line in a mid-west steel mill. Operating *every 3 seconds*—20 times per minute, 1200 times per hour—they have given over 25,000,000 operations—with NO MAINTENANCE—and are still going strong!

Note the unretouched close-up view below. These sturdy VARI-TIME Relays are not "specials" but were built in regular production. They are standard apparatus—and thousands of other CLARK VARI-TIME Relays and Contactors—in all types of heavy industry—are giving equally good service.

and here's the CLARK VARI-TIME CORE

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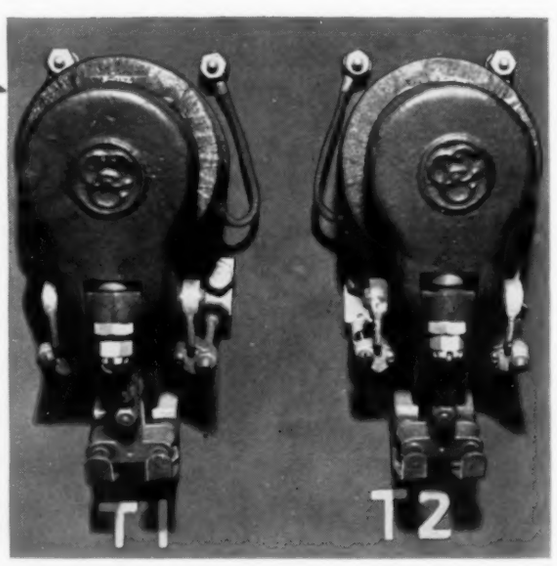

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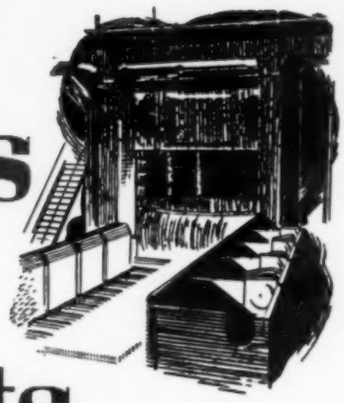


MORE and more, the steel industry of the United States is evidencing interest in various foreign countries, both as sources of raw materials and as potential steel customers. The most recent interest has centered in Venezuela, which is said to have the largest accessible iron ore deposits in the world. Bethlehem Steel Corporation is leading in this development, but U. S. Steel, Jones and Laughlin and Republic are all reported to be investigating the territory.

Bethlehem is building a 32 mile narrow-gage railway from open-pit mines to the Orinoco River, where ore will be transferred into barges and moved to an ocean port.

▲

CONSIDERABLE activity is reported in the iron and steel industry of Australia. A new company, Western Steel Enterprises, has been formed to establish plants on the coast of Western Australia. The company will hold a controlling interest in Western Rolling Mills Proprietary, Ltd., which will concentrate on special steel products, in Westeel Proprietary, Ltd., which is the major steel project, and in Western Australia Coal Mines Proprietary, Ltd. Ore will be obtained from Koolan Island and coal from Collie.

Another major development is the announcement of construction of a hot and cold strip mill at the Port Kembla works of Australian Iron and Steel Co., Ltd., an associate company of Broken Hill Proprietary Co., Ltd.

It is also reported that United States Steel Corporation is planning to enter the Australian field. Although the exact nature of its venture has not been made public, it is believed that it will involve capital investment and technical assistance.

▲

WE hope that none of our readers have missed the eight-page biographical sketch of John L. Lewis, prepared by Allied Syndicates, Inc., who were originally hired to publicize the miners' drive for retirement pensions. Some of its more scintillating gems:

"He is one of the most affable, big-hearted men on the American scene."

"He dresses immaculately, feels at home with children, and knows how to please them."

"He possesses an old-fashioned courtliness that is too often lacking in other great leaders . . . rarely partakes of alcoholic beverages, but his cigar is famous."

"A keen student of Napoleon and military strategy . . ."

SPEAKING before the recent meeting of American Iron and Steel Institute, Clarence B. Randall, president of Inland Steel Co., said that taxation has made the few remaining rich negligible as a source of money, and that industry must now turn to its workers and to the farmers for new risk capital. He estimated that fewer than two per cent of the steel workers own stock in their companies, and stated that the resulting benefit to the cause of free enterprise will be worth the tremendous effort that will be worth the tremendous effort that will be involved in interesting steel workers and farmers in common stock ownership.

▲

ALSO speaking before the Institute, Hugh Morrow, chairman of Sloss-Sheffield Steel and Iron Co., stressed a thought that quite a number of individuals are beginning to accept. Mr. Morrow said that the nation will eventually have to look to the south to save it from alien thought and alien action. He stated that the south is now in the forefront of a movement defending and fighting for an eternal principle — of building from within and not from without.

Mr. Morrow also referred to King Solomon, the man of 1000 wives, as the first WPA worker, but added that, instead of leaning on his shovel, Solomon took his pick and went to bed.

▲

THE Gary medal, awarded by the American Iron and Steel Institute for outstanding achievement in the iron and steel industry, is perhaps the highest accolade that a steel man may receive. Prior to this year, the medal has been awarded to only eight individuals since its inception in 1927. This year the award was made for the ninth time. The surprised recipient was Benjamin F. Fairless, president of United States Steel Corp. It couldn't have happened to a nicer guy.

▲

A REPORT issued by a research committee of the American Gas Association states that large scale production of low purity (95 per cent) tonnage oxygen can be carried out to yield the gas for industrial purposes at a cost of between $4 and $5 a ton.

▲

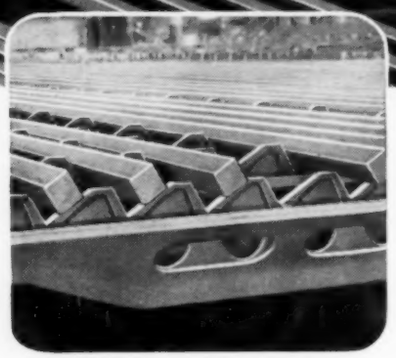
EVERY once-in-a-while we see a magazine article protesting the unfairness of women doing men's work and not getting men's pay for it. Come to think of it, though, we've never seen any published protests about women getting men's pay without doing any work.

▲

ACCORDING to word from Freeman H. Dyke, who is in Chile as general manager of Compania de Acero del Pacifico, work on the new plant at Santiago is progressing nicely. The coke ovens are nearing completion, the sheet mills are being installed, and the blast furnace and merchant mill buildings are being erected. Approximately 4600 men of various trades are employed. It is expected that sheets will be made in October from imported bar and that steel will be produced next March.

▲

IT probably is not really so that the Russians are carefully combing the American mail-order catalogs looking for new things to invent.



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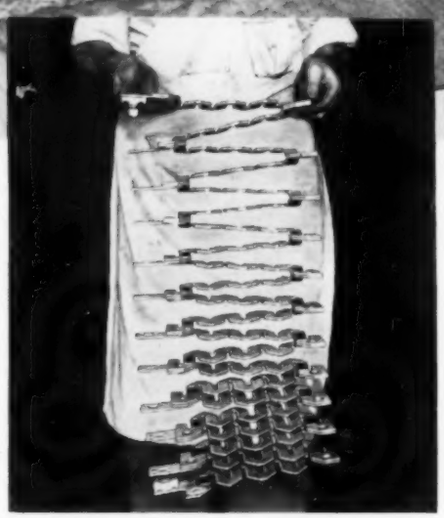

This illustration shows how welding provides a continuous path throughout each section to:

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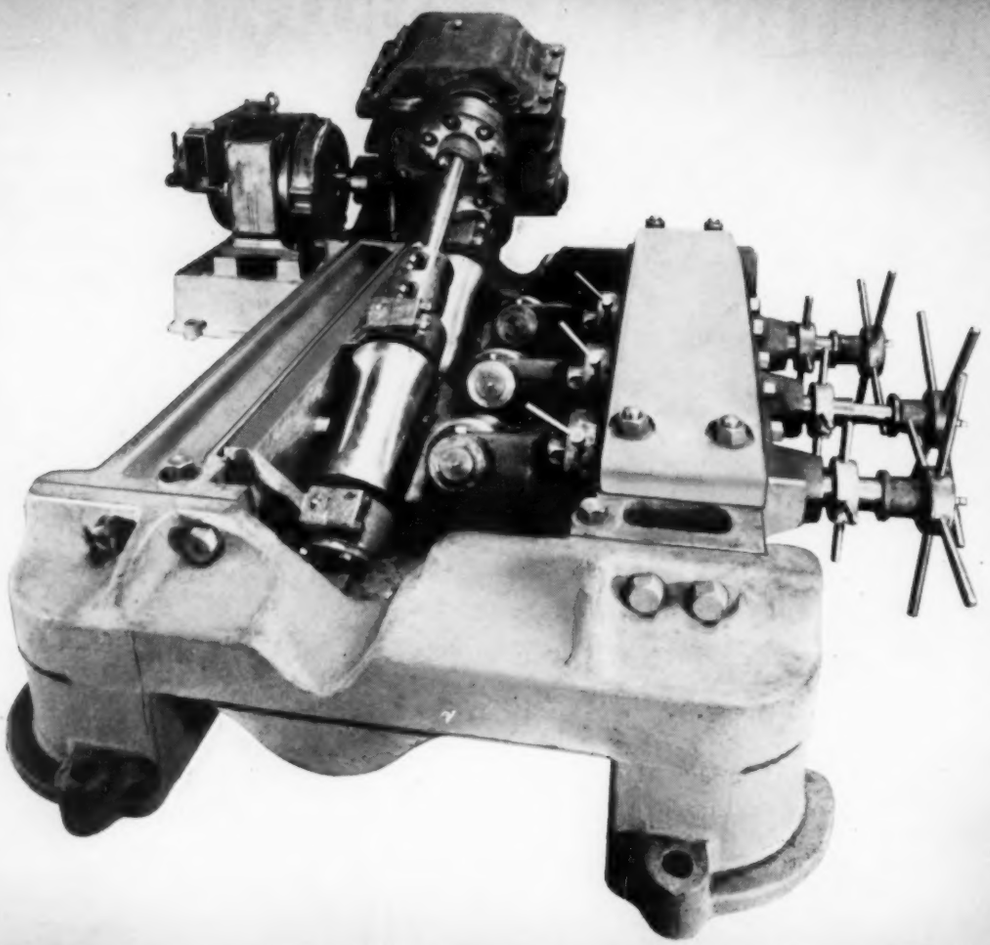

Wean Announces

. . . TUBE, BAR, AND SHAPE STRAIGHTENING MACHINES

WEAN Equipment Corporation, Cleveland, Ohio, recently concluded an agreement with Joshua Bigwood and Son, Limited, Wolverhampton, England, whereby Wean Equipment Corporation has entered into an exclusive arrangement for the manufacture and sale of Bigwood tube, bar, and shape straightening machinery. Bigwood, established in 1874, is one of the oldest and most experienced heavy machinery firms in England.

The main plant of the Wean Equipment Corporation is located in Cleveland, Ohio, and, in addition to this line of straightening machinery, specializes in the manufacture and sale of strip, wire mill and wire fence machinery.

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Iron AND Steel ENGINEER

JUNE, 1949 VOLUME XXVI NUMBER VI

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Published Monthly by
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expression of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

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Indexed by Engineering Index and by Industrial Arts Index.

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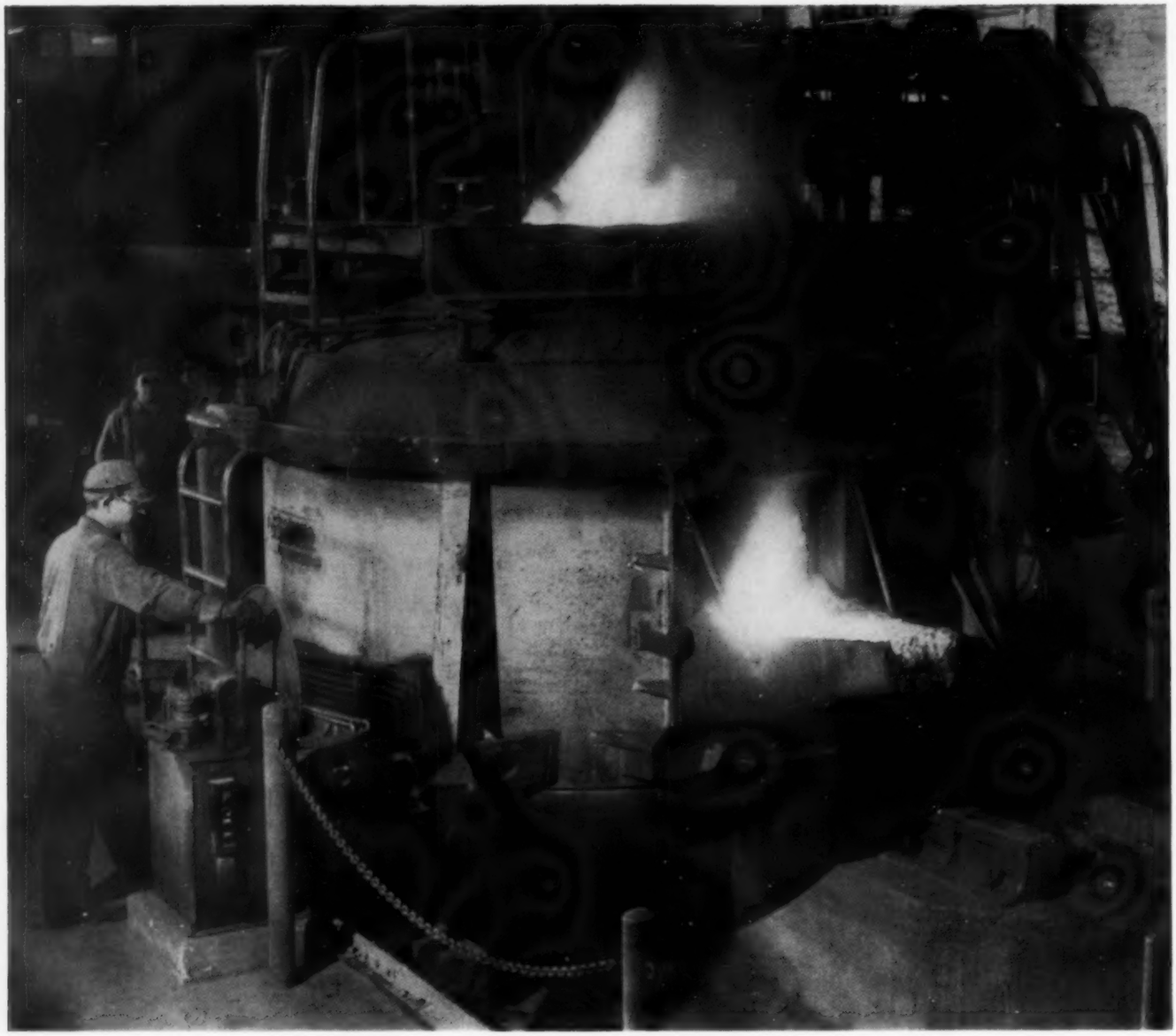

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Beam and Channel Roll Design

By ROSS E. BEYNON
Superintendent, Roll Shop Dept.
Carnegie-Illinois Steel Corp.
South Works
Chicago, Illinois

ROSS E. BEYNON

. . . . with this discussion on beam and channel roll design, Mr. Beynon adds a seventh chapter to his previous comprehensive papers which dealt with bar mills, blooming and billet mills, structural mills, rail mills, rod mills, and basic principles of rolling . . . .

▲ THE following discussion is on the subject of roll design for beams and channels, and the pass drawings, with a few exceptions (and those few confined to pioneer designs), are of existing layouts of mills in the United States. The drawings of the modern designs are fully dimensioned so that they may be drawn up full size by those students of the art of roll design who are interested in seeing the full size detail of the passes.

Historically, rolled beam manufacture started in France in 1849 and in this country at Trenton, N. J. in 1854. A beam shape had been proposed by Tredgold as early as 1824 but no mills of the time were willing to try to roll it and it was to be of cast metal.

The rolling of tees is said to have commenced in the period of 1828 to 1830. Zores of France had been using small rolled tees in building construction and in the year of 1847 he designed a tee of 4 in. in height and 2.38 in. in width by 0.39 in. thick, but no rolling mill would undertake to roll it though smaller tees were being made. In collaboration with a contractor named Chibbon, a tee was designed and fabricated, made of plates with angle connections (see Figure 1, Drawing 1). This proved weak so two more angles were added on top and the parts were welded together to form a beam section. See Figure 2. This is believed to be the first "I" beam shape of rolled material used in building construction.

In 1849 Zores was able to have four beam sizes rolled ranging from $3\frac{15}{16}$ in. to 7.08 in. in depth and slightly

Drawing 1 — Some early sections rolled or proposed by the industry.

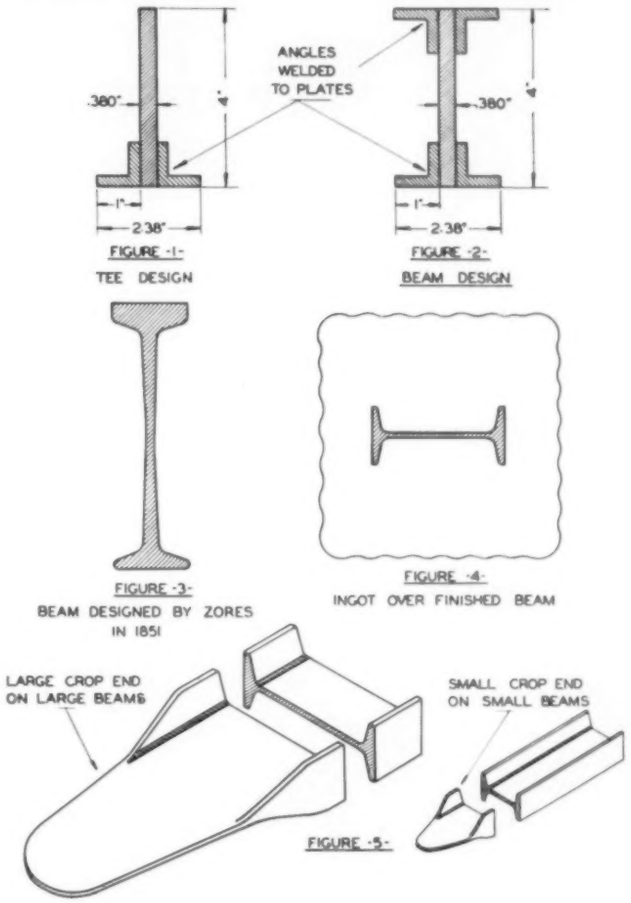


FIGURE -1-
TEE DESIGN

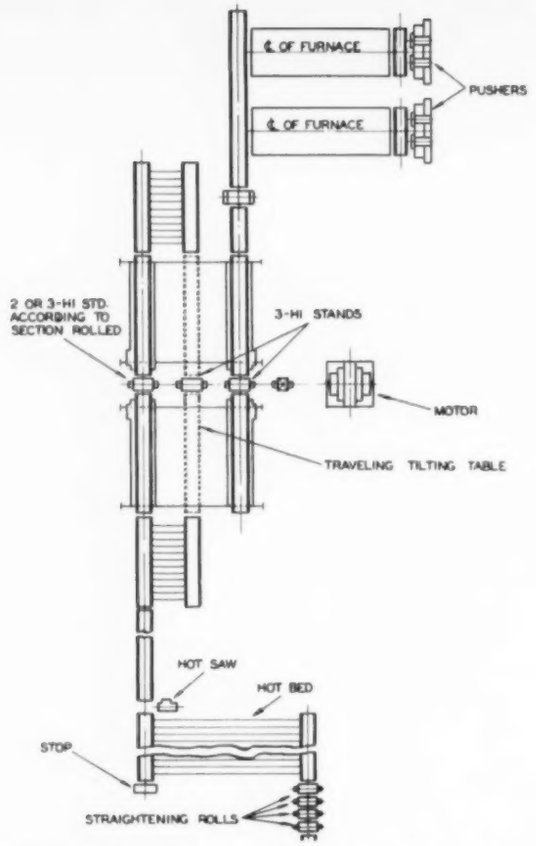
FIGURE -2-
BEAM DESIGN

FIGURE -3-
BEAM DESIGNED BY ZORES IN 1851

FIGURE -4-
INGOT OVER FINISHED BEAM

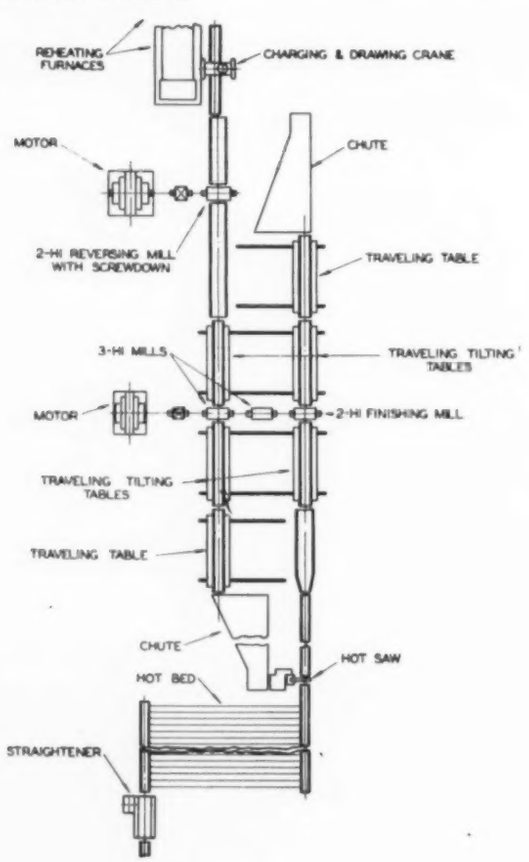
FIGURE -5-

Presented before AISE Annual Convention, Cleveland, Ohio, September 30, 1948



Drawing 2 — This 3-stand structural mill is of the simplest type.

Drawing 3 — Structural mills with separate breakdown are more versatile.



over 20 ft long. At the time it was proposed to have the top flanges of these beams heavier than the bottom, but the mills refused to roll such unequal sections and both flanges were made alike. With the new beams Zores conducted a series of investigations on stresses. He arrived at the conclusion that the cross-section of the beams in the web neutral axis zone could be thinner and that the top flange should be thicker than the bottom one. No mill would undertake to roll the section. See Figure 3.

Numerous authors, particularly of the European school, have written of beam and channel roll design. A few have shown charts giving the drafting for beams and channels. In one publication the author's charts give 17 passes to roll a 15 in. beam while another produces the same section in 11 passes.

On channels the first author uses 17 passes to produce a 15 in. channel, using the butterfly method while the other used only nine passes and employed the straight method.

The practice used in this country permits a structural channel to be rolled in seven passes by the butterfly method and it usually takes nine or more to produce it by the straight design.

Students of designing trying to develop workable sections by the use of charts would soon discover that each design must be adapted to local conditions.

Though the general features of structural mills may be somewhat similar, there are many differences which affect the roll design such as the blooming mills furnishing the stock, size and capacity of the finishing mill. heating furnaces, roll diameters and lengths, number of passes available, and other variable conditions.

It has often been said that no two roll designers would lay out a section the same way, and this is quite true. Knowledge of designing is acquired through intensive study and long experience, and a roll designer's views of the art are often influenced by the work and ideas of his predecessors. The local mills may be of a type which do not lend themselves to new and radical designs and thus the designer's work may have been confined to a narrow field. Another designer, more fortunate in the mills for which he is designing, may have better opportunities for work and study and thus develop a more versatile style in design. Two designers of the types just described would be very unlike in their design of similar sections.

Often it is found that there may be several possible ways of rolling a given section, but for each mill there is one layout which is the best and that is the design which gives the best yield, the least trouble in rolling, the best tonnage, and the lowest cost consistent with good practice.

In beams and channels we are considering only two types of sections but there are many kinds of beams and channels, large and small and of varied proportions. Some beams have large flanges with little taper and others small flanges with a good taper, and this also applies to the channels.

The large beams with the wide flanges require the most passes to produce while the smaller ones often may be produced in a few well designed grooves.

On the standard structural mills in this country, a 10 in. flange is the largest produced and that only as a special section of one mill. European structural mills average considerably larger roll diameters than ours and they have been able to produce up to 12 in. flanges on beams, while we confine ourselves to flanges slightly over 8 in. in width, with some exceptions, leaving the large flanges for our universal beam mills.

DESIGN OF BEAMS

In the design of a beam, the problem confronting the designer is to convert a rectangular or shaped ingot to a beam shape. Refer to Figure 4 of Drawing 1 which shows a beam over an ingot. It can readily be seen that in shaping the beam there will be more reduction in the web in the vertical direction than on the flanges.

The early forming of a beam shape is one of the first considerations in the beam design. The designer is usually forced to use existing blooming mills for the blank or bloom and there is little choice in this matter. Most blooming mills now operating in structural plants are of the two-high reversing type, so suitable passes for such mills must be designed.

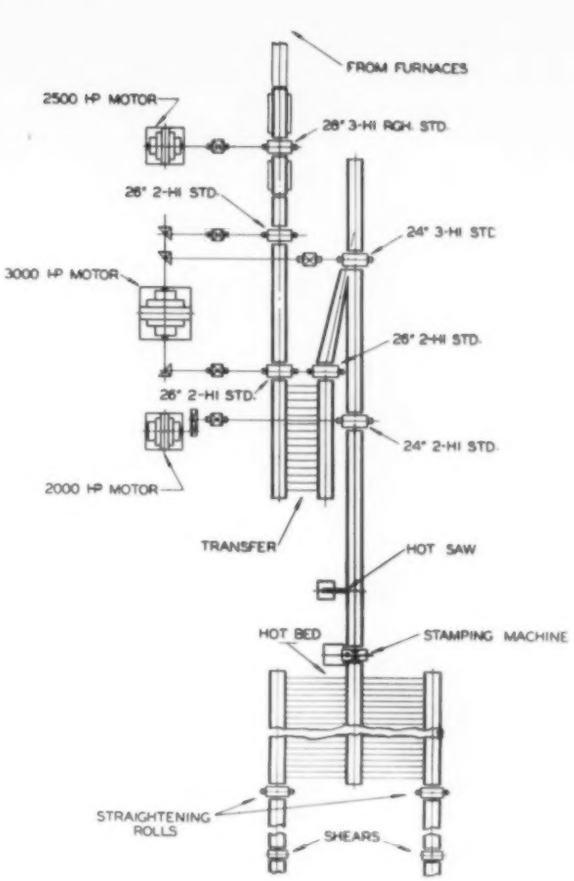
The larger beams on standard structural mills are produced from shaped beam blanks. The smaller beams are produced from rectangular blooms and the size and layout of the finishing mills dictate the number of available passes and whether the beam is to be rolled from a bloom or a shape.

Even though the mill is so designed that sufficient passes are available there are limiting factors in the use of rectangular blooms. Where the mill design includes a separate reversing roughing mill, 15 in. beams and smaller are rolled from a rectangular bloom while beam shaped blanks are used for beams over 15 in. Mills which do not have two-high reversing roughers are usually forced to use beam blanks for beams down to 10 in. in size.

The reason for this is the heavy reduction which must be done on the web in forming the section. In the larger sizes the web width is considerable and the formation of the web takes a large number of passes. In the smaller sizes the web is not too large and it can be formed quickly. The breaking down of the web in the big sizes causes extreme elongation of that part as compared to the flange elongation while in the narrower beams this difference in elongation is not as pronounced (see Drawing 1, Figure 5). This extreme web elongation of the larger beams not only makes a long crop on the finished bar with resultant loss of yield, but also creates difficulty in handling during rolling, sometimes forcing the beam out of the pass and into the roll collars, causing cobbles and broken rolls.

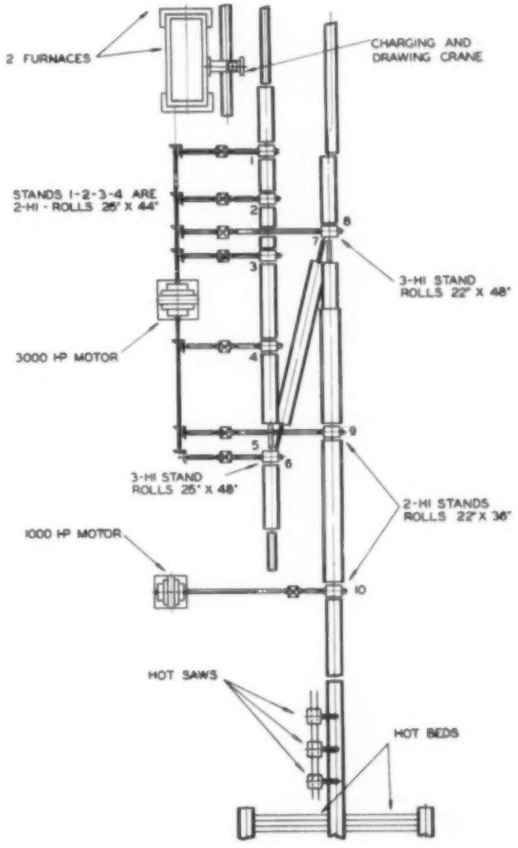
In the narrower beam sizes the width of the web is small and the rolls have a good cutting action on this part and the web elongation is not extreme as in the large beams.

However, even in the sizes 15 in. and under, rolling from a rectangular beam takes more passes than from a shape, and the number of passes available tell the designer whether or not he must use a shaped bloom.



Drawing 4 — A 24 in. cross country mill with 3-high roughing.

Drawing 5 — The cross country structural mill yields good tonnages.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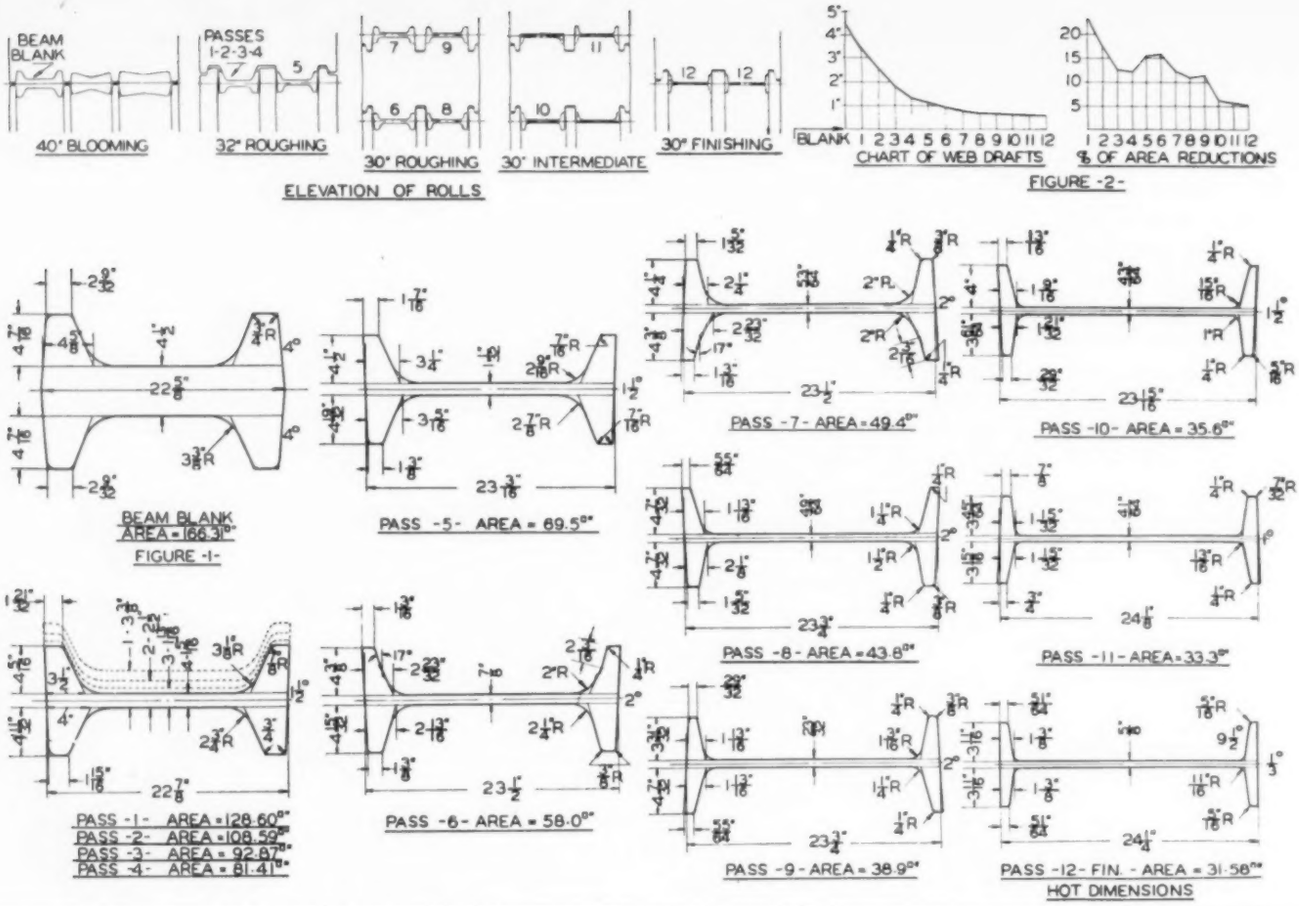


STRUCTURAL MILLS

There are three common types of standard structural mills in use in this country. Drawing 2 illustrates the simplest type. In these mills the stands are in line on the bedplate and are all of approximately the same roll diameters and driven at the same speed.

In a mill of this type the roll lengths and number of stands limit the number of passes which may be employed and the roll diameter limits the depth of groove. These limitations affect the size of beam which can be rolled from a rectangular bloom. A 10 in. beam is about the maximum rolled from a rectangular bloom on a mill of this kind.

Another limitation is roll speed. Many mills of this kind do not have variable speed motors and thus have only the one roll speed. The large reduction necessary in the first passes for beams when rolling from rectangular blooms causes heavy shocks on the mill when the bloom is entering at the full mill speed and the bloom would not enter if the passes were not heavily ragged to pull the bloom in; the larger the beam rolled the greater is this difficulty.

Some of these mills have variable speed motors where the mill can be slowed almost to a standstill to facilitate the entrance of the bloom. Slow speed permits better entrance of the heavily drafted blooms while the higher speeds have a tendency to repel the bloom.

Drawing 3 shows a better and more versatile mill design. In this layout a separate roughing stand has been placed ahead of the finishing mill.

There are seven mills of this general type in North America and in all of these mills the roughing stand is a two-high reversing mill with screwdown and turnover manipulators.

Mills of this kind have great advantages over the simple one first described. There are many more passes available and the roughing speed is adjustable. Very slow speeds can be used for heavy drafts and the lighter drafted passes can be speeded up. The screwdown is a great advantage as a variety of draft settings may be used. When breaking down a shaped blank or a rectangular bloom one groove may be used for several passes.

On mills like this it is common practice to roll 15 in. beams and under from a rectangular bloom, and one or two instances are known where 18 in. beams have been rolled from a bloom. These mills, without a doubt, are the most versatile of all standard structural mills.

The third type of mill is the cross-country mill and Drawing 4 shows one of these mills, only partly cross-country, however, as it has a three-high roughing in advance of the cross-country stands where several passes are taken.

Drawing 5 shows another of the cross-country structural mills of the country. The pinion pitch diameters in the roughing stands of this mill are 24 in. and in the finishing stands 21 in. in diameter with the rolls somewhat larger. The roll speeds are graduated from a very slow one in stand 1 to a high speed in stand 8. Stands 1-2-3-4-7 and 8 are two-high and only one pass is taken in each stand. Stands 5 and 6 are three-high and two passes are taken in these stands. The advantages of a mill of this kind are obvious; the slow entering speeds of the roughing permit heavy drafting and the grad-

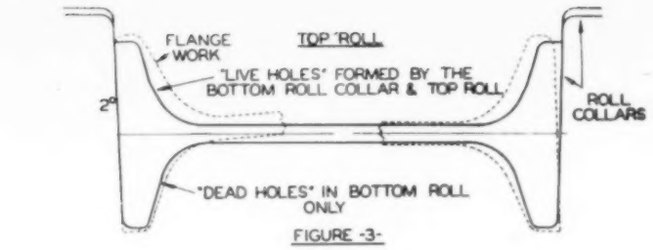
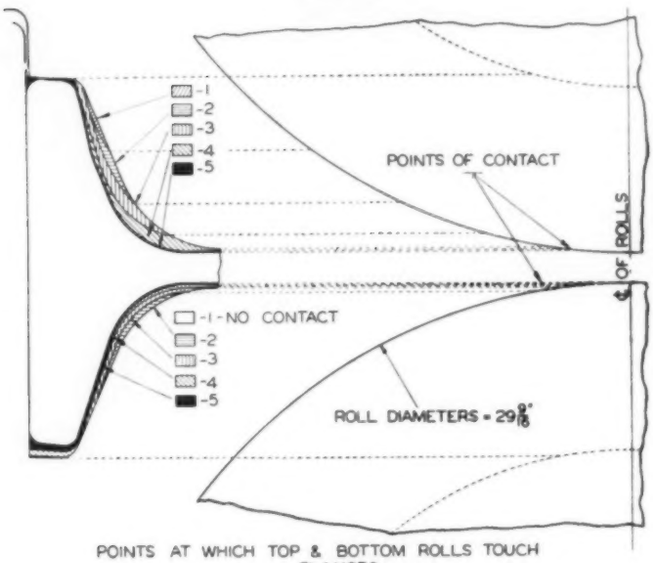


FIGURE -3-



POINTS AT WHICH TOP & BOTTOM ROLLS TOUCH FLANGES

FIGURE -4-

Drawing 6 — Passes for 24 in. x 7⅞ in. x ⅝ in. x 105 lb beams.

ually increasing speeds from stand to stand allow fast delivery and permit several bars in the mill at the same time. As many as seven pieces may be in the mill at once which naturally gives fine tonnages. There are a number of these cross-country mills of the same general design in operation though differing in details.

These standard structural mill types have been shown in order to emphasize the effect the mill's layout has on the roll design. The roll speeds, roll diameter, bar temperatures, and number of passes available are all different in these mills and limit the roll designer in his choice of designs. There are many ways in which beams and channels may be rolled and large sizes have been rolled on small mills and small sizes on large mills all made possible through clever roll designing. Large sizes on small mills may represent economies in roll and production costs but small sizes on large mills can never be economical because the roll and production costs are far too high. The following pass designs are typical for some of the mills which have been shown.

24 IN. STANDARD BEAMS

Drawing 6 shows a 24 in. x 105 lb beam with 7⅞ in. flanges as produced on a mill of the type shown on Drawing 3. The beam blank (Figure 1) is produced on a 40 in. two-high reversing blooming mill.

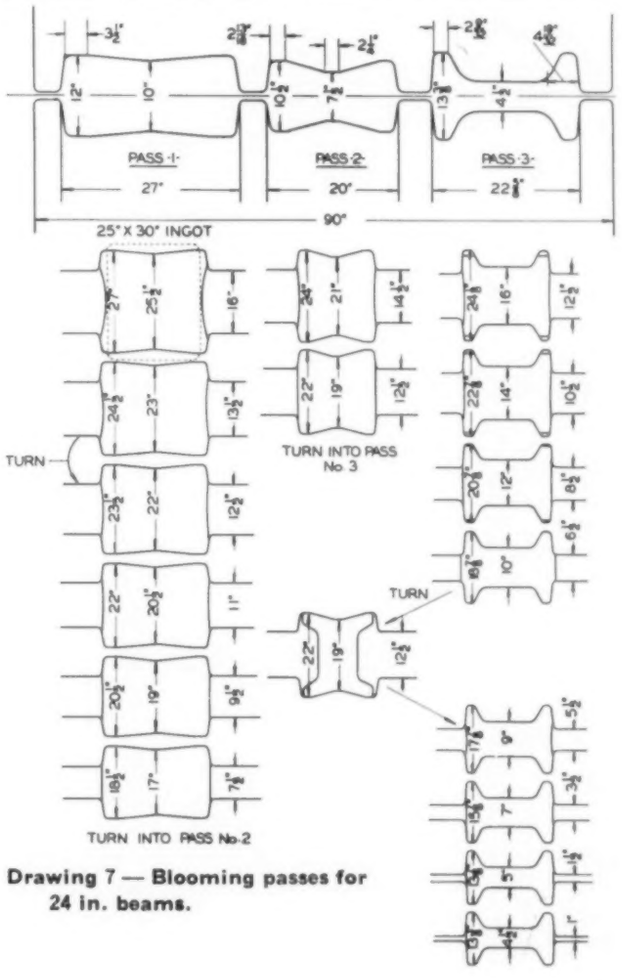
In the designing of the beam the finishing pass is drawn first and the development is back to the blooming passes.

The first step is to draw the finishing pass of the beam to the hot sizes which are set for a shrinkage of 1/64 in. per 1 in. in every part, except the beam depth and flange thickness. The beam depth dimension is set for a shrinkage of 0.01 in. per in. as it is desired to have the beam under 24 in. at the initial rolling to allow for pass wear. Owing to the small taper of the roll on the outside of the flange which is ⅓ of 1 degree the pass gets wider at each dressing.

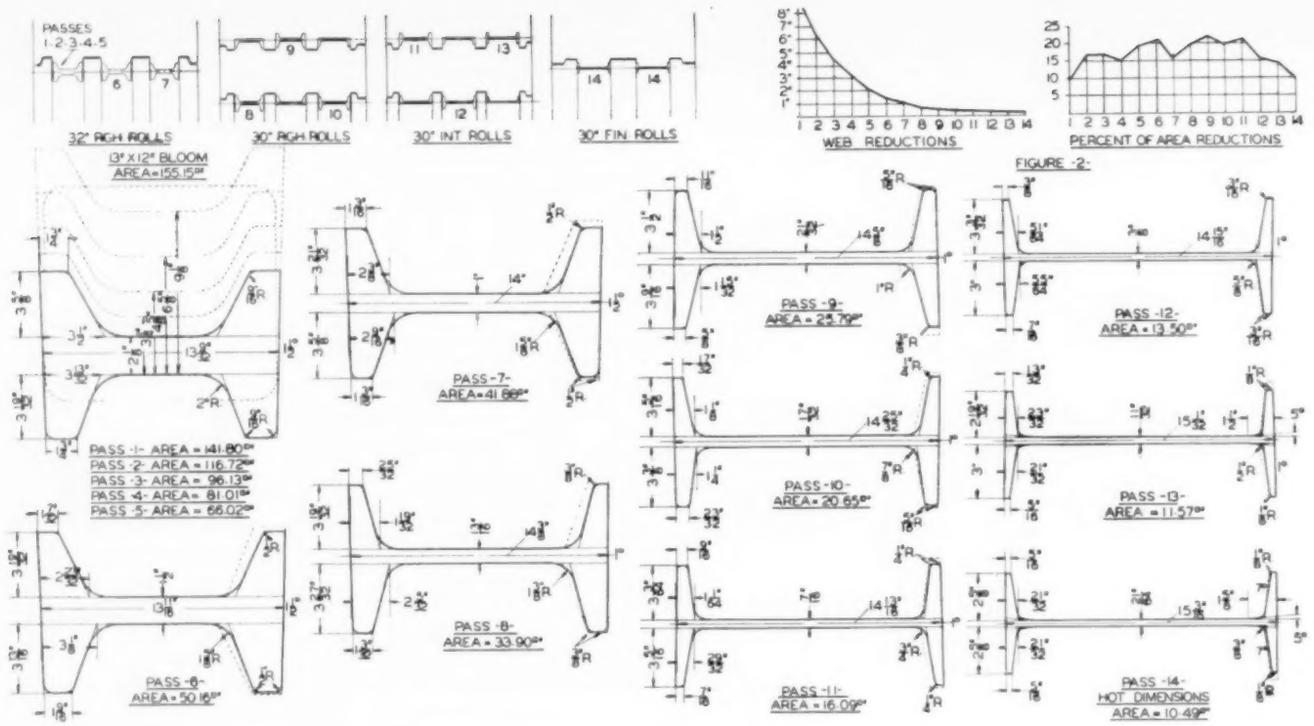
No shrinkage is allowed in the flange thickness, because there is some wear during a rolling which increases flange thickness, and rolling the flange to the underside of the tolerance permits the weight per foot of the beam to be kept on the under side.

Very light drafts are taken on a beam in the finishing passes for a number of reasons. One is to reduce pass wear and insure a smooth appearing section. Another is that hard rolls are used and these are not strong. The web reduction is kept at a minimum, usually 1/64 in., rarely more than 1/32 in. This is to keep any suspicion of a buckle out of the web as well as to keep the roll from wearing rough.

The side work on the flanges of this 24 in. beam is 3/32 in. on the live holes and an average of about 3/64 in. in the dead holes; in addition, the dead hole has ¼ in. end work on the flanges. These amounts are necessary to completely fill the holes and to allow the flanges to elongate freely and not be stretched by the web elongation. The flange entering the live hole is made longer than the part it enters to allow for some drawing down of the flange due to elongation. From the finishing back



Drawing 7 — Blooming passes for 24 in. beams.


PASSES 1-2-3-4-5
32" RGH ROLLS
30" RGH ROLLS
30" INT ROLLS
30" FIN ROLLS
WEB REDUCTIONS
PERCENT OF AREA REDUCTIONS
FIGURE -2-
3" X 12" BLOOM
AREA = 155.15"
PASS -1- AREA = 141.80"
PASS -2- AREA = 116.72"
PASS -3- AREA = 96.13"
PASS -4- AREA = 81.01"
PASS -5- AREA = 66.02"
PASS -6- AREA = 50.16"
PASS -7- AREA = 41.66"
PASS -8- AREA = 33.90"
PASS -9- AREA = 25.79"
PASS -10- AREA = 20.65"
PASS -11- AREA = 16.09"
PASS -12- AREA = 13.50"
PASS -13- AREA = 11.57"
PASS -14- HOT DIMENSIONS AREA = 10.49"

Drawing 8 — Passes for 15 in. x 35 lb beams.

a gradual increase of draft is given, the leader pass being drafted rather light also for the same reasons as given for the finishing.

In Figure 2 of Drawing 6, charts of web draft and area reduction are given. The web chart shows the gradual increase in draft and this is important as more or less web work affects the flange height, more work having a tendency to draw the flange down and less work doing the opposite. The flange side draft, however, is increased more rapidly than the web draft.

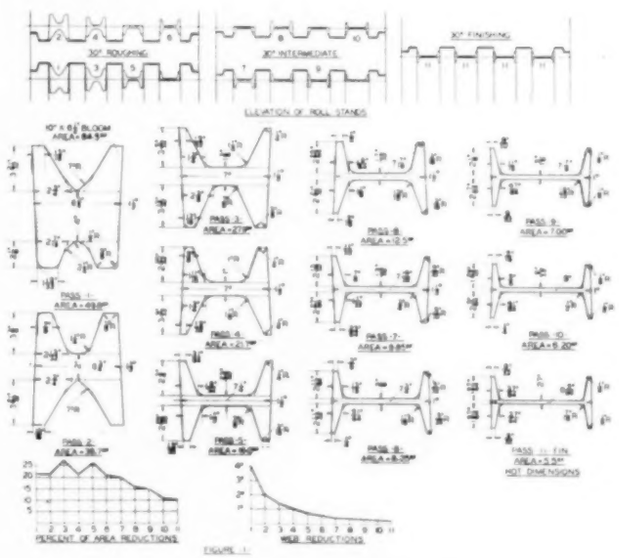
The web reduction shows a gradually increasing draft, but the reduction in area follows a somewhat irregular pattern, and this is true of practically all beam designs rolled on standard structural mills. The area reduction is rarely considered unless some power question is involved, and even though the area reduction is given consideration, it will not be graduated uniformly as in the case of the web reduction.

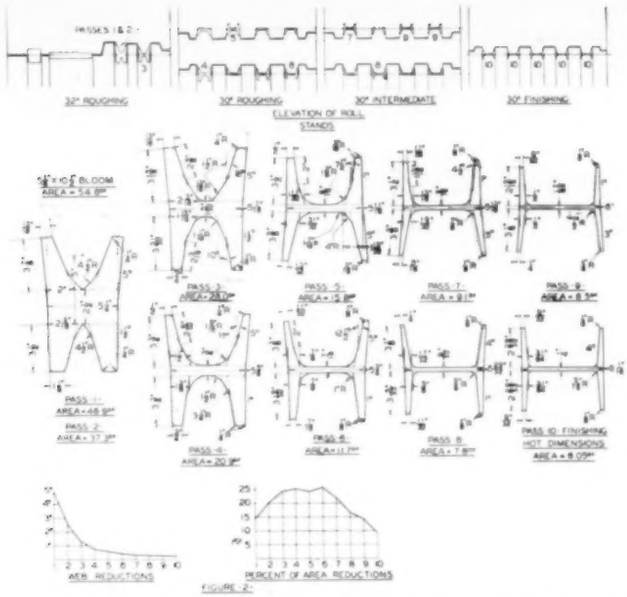
It is customary to allow a certain amount of spread in web width from pass to pass. This is not a definite amount but is allowed according to the designer's judgment of what it should be. The finishing pass with a collar taper of $\frac{1}{3}$ of 1 degree will wear wide faster than the leader, with its 1 degree taper, and this will increase the spread as the passes wear and are dressed. Too much spread will tend to cause a loss of flange height while a small amount of spread will give excessive wear on the collar sides of the passes. No certain rule can be set for spread and the designer must exercise good judgment in this.

As the flange and web work is increased from pass to pass the danger of the so-called pass "choking" becomes a factor which must be considered. In a study of a great many cobbles it was found that in nearly all cases of underfilled flanges the live flange was underfilled while the dead flange was filled.

At this point it might be well to illustrate what is meant by the expressions "live" and "dead" holes or grooves. Refer to Figure 3 of Drawing 6 which shows a beam pass. The lower part of the pass is, as can be seen, entirely in the bottom roll. The upper part of the pass is formed by the collar of the bottom roll and the upper roll. In this lower flange formation there is no direct rolling such as would be had by two rolls working together on a bar. The only direct rolling action is on the bottom of the flange in an up and down direction. The pioneer roll designers said that there could not be any side reduction in a pass of this kind, so they called the groove a "dead hole." The upper flange being rolled and drawn between two rolls and having considerable side

Drawing 9 — Passes for 8 in. x 4 in. x 0.27 in. x 18.4 lb standard beams.

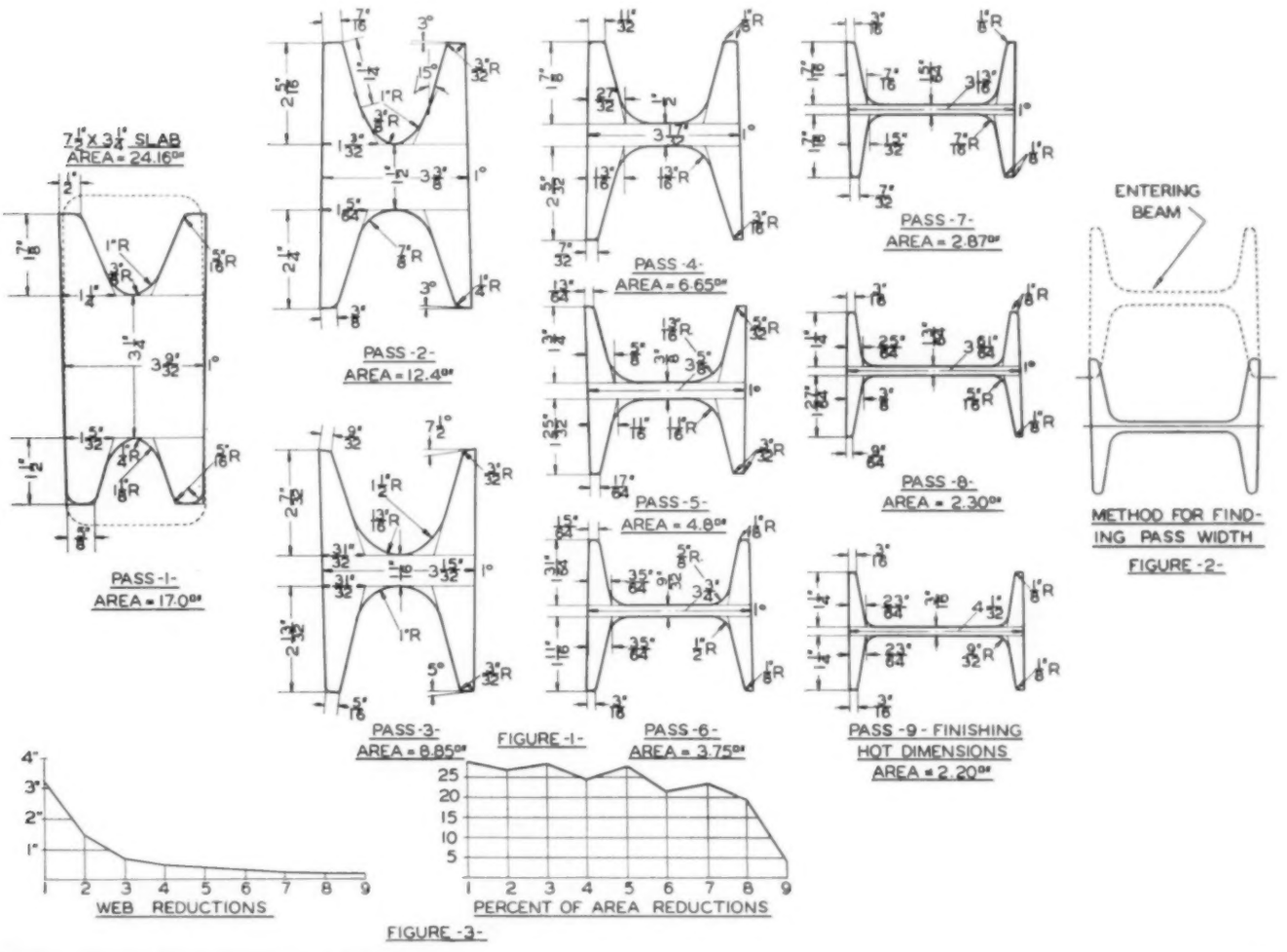


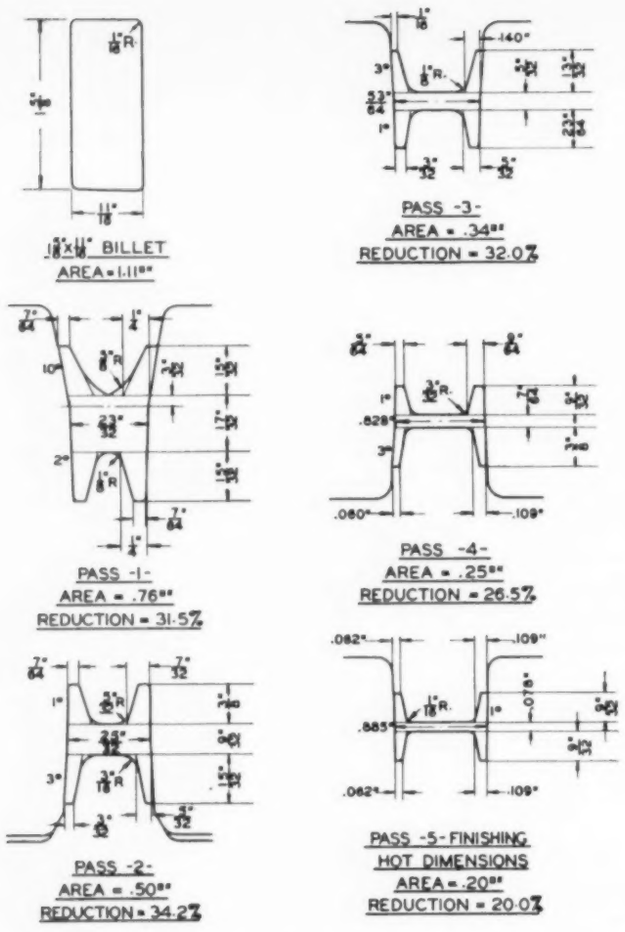


Drawing 10 — These 6 in. x 5.93 in. x ¼ in. x 20 lb "H" beams are rolled by straight flange method.

reduction was called the "live hole." To resume—the fact that live flanges were underfilled while dead flanges were filled led to the conclusion that excessive side flange work in the live holes caused the underfilling by choking the pass. The dead holes were filled by virtue of the fact that there was little side work and by the upper flange being shoved in the rolling action down toward the lower. Refer to Figure 4 of the drawing which shows how the tongue of the upper roll as it rolls the bar forms a ridge. This figure shows how the top roll tongue touches the flanges of the beam as it enters the pass. There are five positions shown and they are indicated by the Figures 1-2-3-4 and 5. The first position shows how the rolls first touch the flanges and the fifth is where the flanges have reached the center. It will be noted that as the top roll first touches the beam there is a ridge formed on the inside of the flange and the rolling on this ridge is in a downward direction. On the dead flange there is a similar ridge formed but it is much smaller than on the live flanges. The rolling action on these ridges has the effect of pushing the upper flange down thereby shortening it and rolling the metal into the lower flange. Since this is the case, a little reflection will show that increasing the side work in the dead hole and decreasing it in the live hole will remedy the situation to a certain extent. Decreasing the side work on the live holes will relieve some of the down push and increasing the side work on the dead holes will give the bottom flange more resistance to the down push, and the result is a better filled flange. The double taper at the side of the upper roll also helps in relieving some of

Drawing 11 — Passes for 4 in. x 2.66 in. x 0.187 in. x 7.7 lb standard beams.





Drawing 12 — Passes for 7/8 in. x 5/8 in. x 1/4 in. beams.

Drawing 13 — Diagonal rolling as practiced 75 years ago.

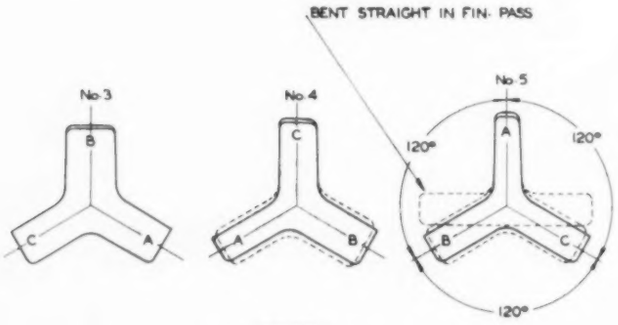


FIGURE -1-
DIAGONAL ROLLING OF TEES
BY DE BUIGNE PRIOR TO 1875

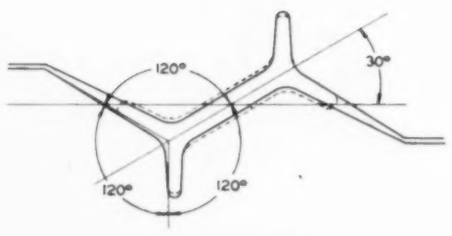


FIGURE -2-
DIAGONAL BEAM ROLLING
BY DE BUIGNE -1876-

the down push as it increases the pass angle and allows the flange to slide up higher in the pass.

WORKING PASSES OVER EACH OTHER

In this 24 in. beam design the size of the beam is such that it is necessary to work the first four passes in the three-high mill over each other as roll space will not permit any other layout, i.e., pass 7 over pass 6 and pass 9 over pass 8 as shown in the roll sketches. When this is done the live holes of passes 6 and 7 and 8 and 9 are alike in size. This fact makes it difficult to have the proper side work in the dead holes of passes 7 and 9 and is one of the greatest disadvantages of a design of this kind. The dead holes of passes 7 and 9, having little or no work in the grooves are stretched or wire drawn by the considerable elongation of the web and the live holes until they nearly equal the length of these parts.

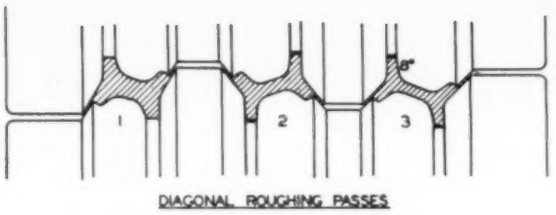
Another expedient which helps to fill the live flange is to make the entering flange, which was rolled in a dead hole, longer to allow for the pushing down that it receives in the live hole. It is very necessary in these beam designs to have the maximum side reduction possible in the flanges so that the flanges will elongate reasonably even with the web. For this reason the heavy side work must be given even though there is a tendency to underfill the live flanges.

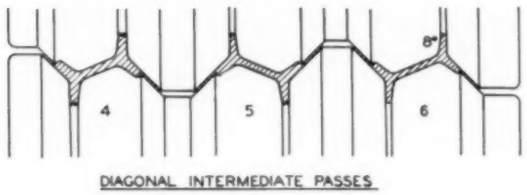
In the type of mill on which this beam is rolled, the two-high reversing roughing stand with the screwdown permits rolling several times through the first groove in the set. The drawing shows the four passes which are used to roll the beam blank to the final setting in this pass. In order to be able to roll long finished lengths the beam blank must have considerable weight. The length of the blank is restricted by furnace length so a considerable overall web and flange thickness is necessary to furnish the weight, and four passes are required to reduce the blank in the first groove.

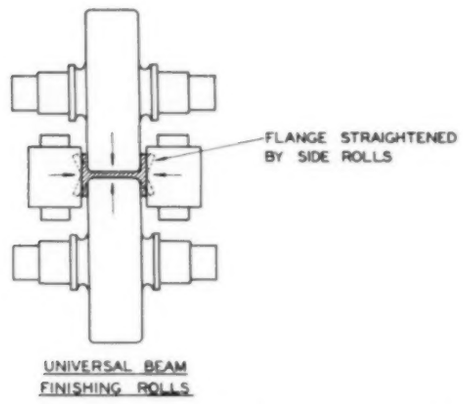
The beam blank roll design is shown on Drawing 7. The 25 in. x 30 in. ingot is entered into pass 1 on edge where it receives two passes, then is turned 90 degrees and given four passes, again turned and entered on edge into pass 2 where it is given two passes and then turned again and entered into the beam blank pass. After four passes the piece overfills at the roll parting and is returned to pass 2 after being turned 90 degrees. The overfill is then rolled off in pass 2 and the piece is returned to the beam blank pass and finished in four passes. The design of the blooming passes is controlled by the overall body length of the rolls. With passes of this size only three grooves can be turned in the rolls and the design shown is the best that can be had with the 90 in. roll length.

SPECIAL 15 IN. X 35 LB BEAM

Drawing 8 shows a 15 in. beam rolled from a 13 in. x 12 in. bloom entered flat. In this design the passes are not worked over each other, as the beam size permits staggering the passes as shown in the roll sketches. This light weight beam has a flange taper of 7 degrees as compared to the 24 in. standard beam taper of 9½ degrees.

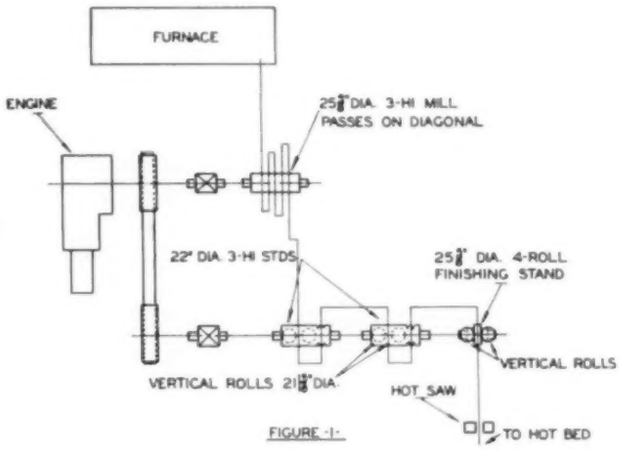


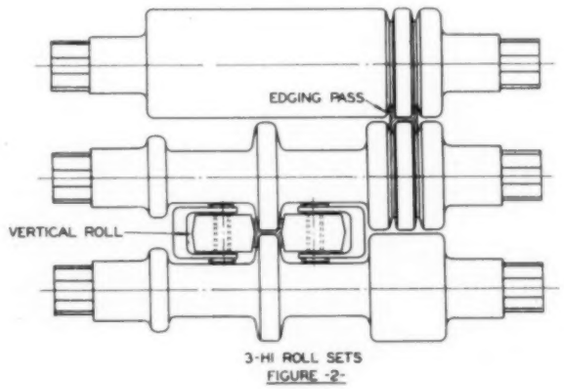




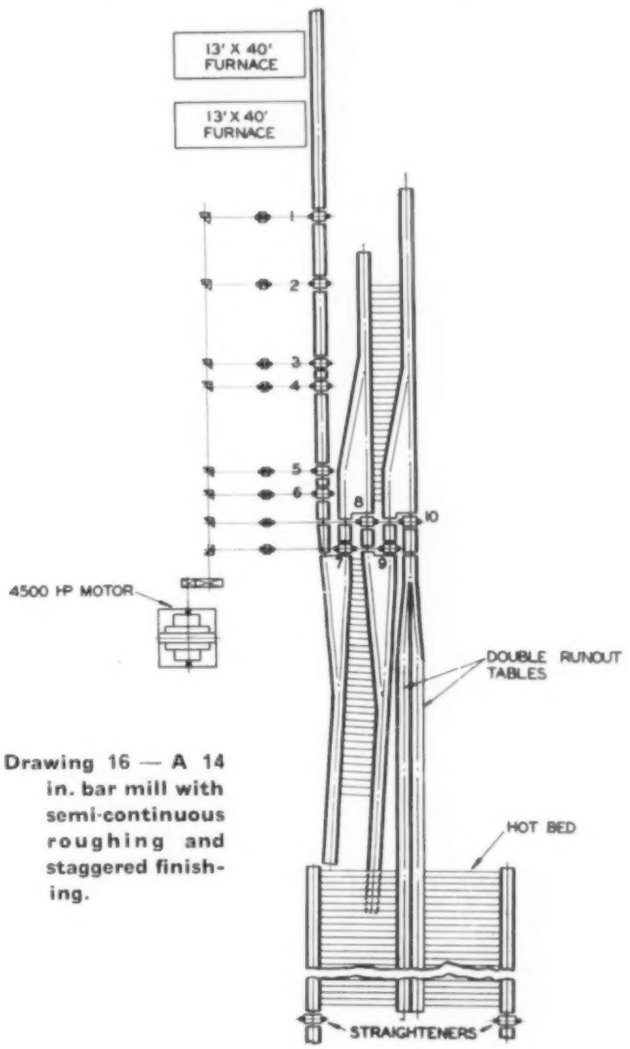
Drawing 14 — Diagonal roughing and intermediate with universal finishing mill.

Drawing 15 — Early German universal beam mill.



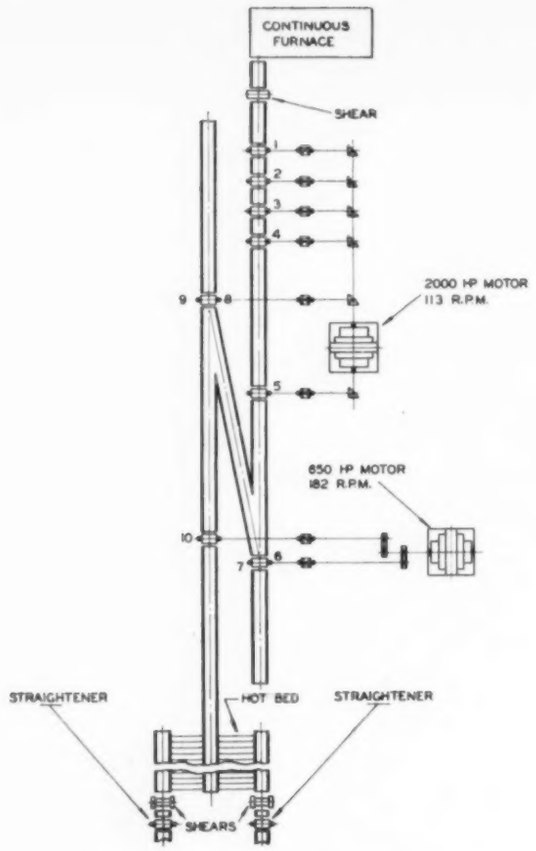


The flange of this beam is connected to the web by a double taper to strengthen the section in the fillet. The drafting of the section is done in much the same manner as in the 24 in. beam just discussed. The fact that there are no passes worked over each other permits a better distribution of draft in the flanges of the earlier passes and eliminates some of the wire drawing of the dead flanges mentioned in the discussion of the 24 in. beam. Pass 9 of this design shows a rather heavy side reduction in the live flange. To counteract the choking and flange shortening effect this will have the entering flange is made $^{9}/_{32}$ in. longer than the flange groove it enters to allow sufficient metal to prevent the flange from running short. This heavy live flange work is continued in pass 7 and 8 to increase the flange thickness to



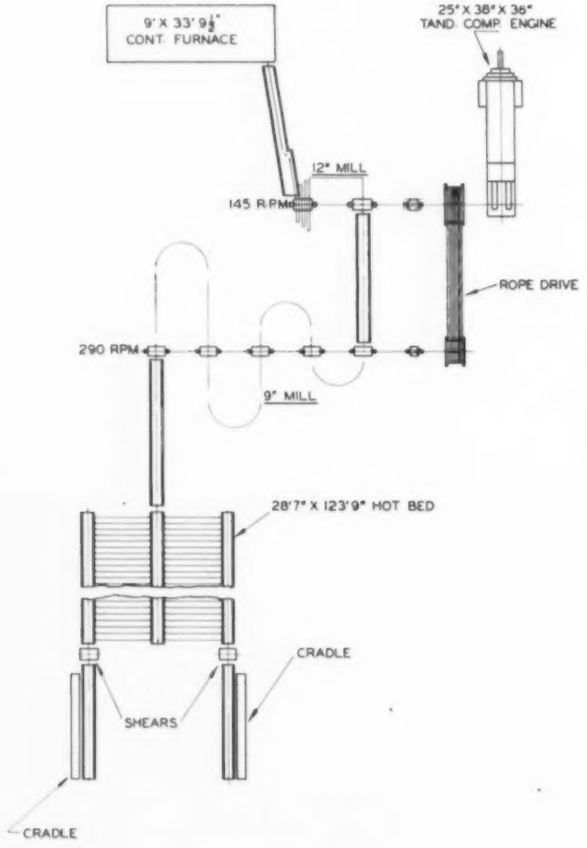
Drawing 16 — A 14 in. bar mill with semi-continuous roughing and staggered finishing.

a point where the shape from the two-high roughing mill will be the right size for the finishing mill passes. The 15 in. beam passes in the two-high roughing mill are the same for all the 15 in. beam sections, of which there are several, and are also used for the 15 in. channels, consequently, they cannot be of perfect size for all the 15 in. finishing mill sections. The three grooves in the two-high reversing mill are drafted as follows, 5 times through the first groove and once each in the second and third groove, turned over from the first to the second groove and also from second to the third. From the third groove the bar is not turned over to enter the first



Drawing 17 — A 12 in. cross country mill.

Drawing 18 — This 9 in. continuous merchant mill is hand operated.



finishing mill pass because it is long at this stage and hard to turn. This means that the live flange of the last pass in the two-high enters the live hole of the first pass in the three-high finishing mill.

8 IN. BEAMS

Drawing 9 shows an 8 in. standard beam design suitable for the three stand structural mill shown on Drawing 2. In this 11 pass design the first four passes are worked over each other owing to lack of space for a better arrangement.

The drafting of the passes from the finishing back to pass 5 is much the same as for any beam of this size, but passes 1 to 4 inclusive must be drafted differently because of their position in the rolls (see sketch of roughing rolls). The live flanges of passes 1 and 2 are alike in size and also passes 3 and 4, working over each other, are alike. This makes it difficult to draft these flanges in the best proportions.

In the first pass the dead grooves are made rather short, as it would be difficult to fill the deeper grooves from a rectangular bloom. The web is left thick so that in pass 2 there will be enough material for the cutting action on the bottom part of the pass to form the full bottom flanges. Once the flanges are fully formed there is no difficulty in maintaining the flanges to the finished beam.

6 IN. "H" BEAMS

On standard structural mills "H" beams are rolled in three different ways—by the straight method, the diagonal method, and by the diagonal and straight design.

Drawing 10 shows a 6 in. "H" beam rolled on the mill shown on Drawing 3 by the straight flange method.

In this design it was desired to roll the beam straight rather than on the diagonal so that there would be no side thrust on the rolls and no twisting of the bars.

The inside flange taper of this beam is 4 degrees. With this small taper a heavy side flange draft would cause choking and underfilling of the flange. To allow a reasonably heavy side flange draft in the live holes without danger of choking, it was necessary to flare the live flanges out as shown on the drawing.

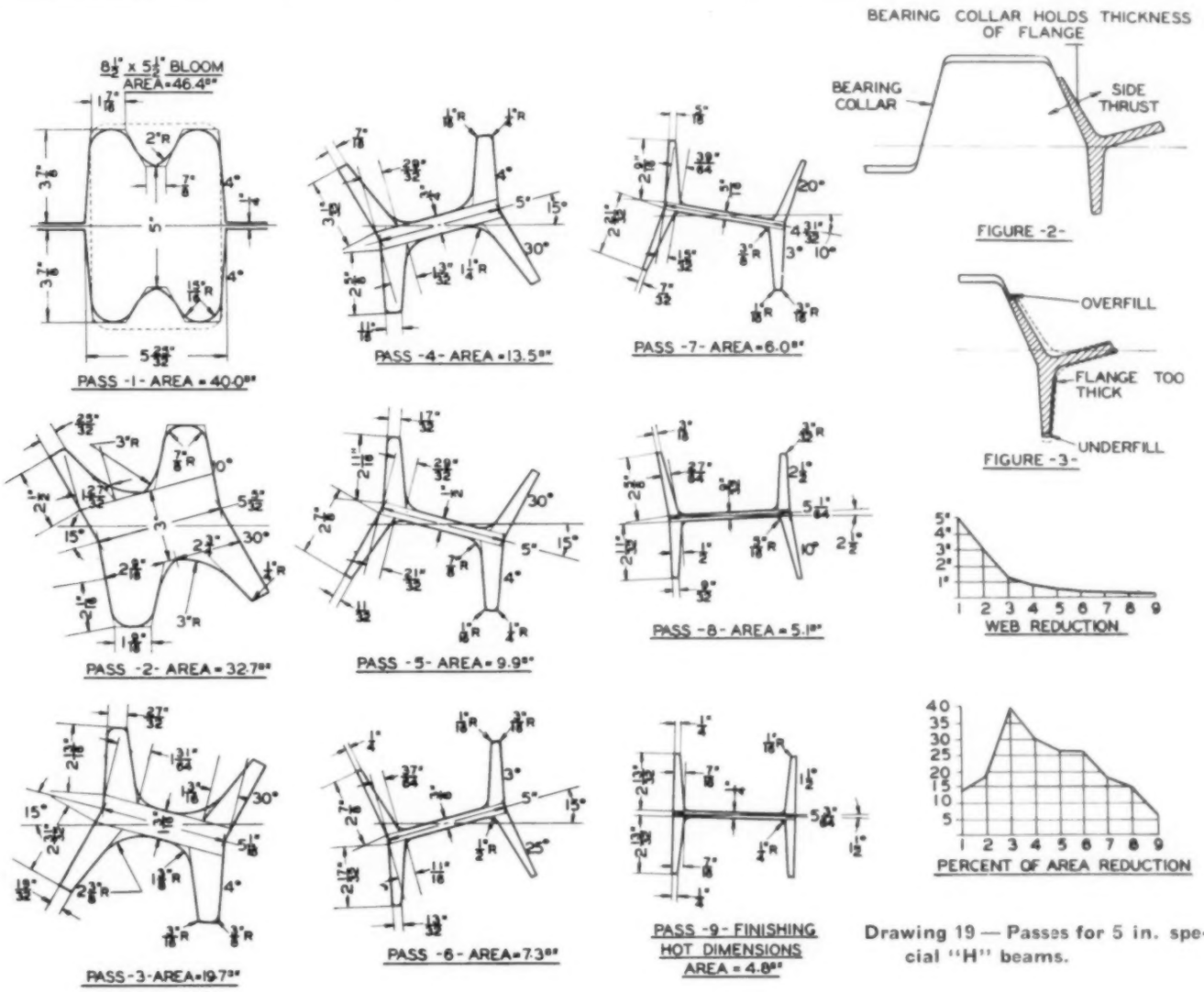
In addition to this a double inside flange taper is used on the first 7 passes. This allows more side work to be given without danger of choking. This feature has already been discussed when describing the 24 in. beam drafting.

The first two grooves in the design are located in the two-high reversing mill and groove 1 is used for two passes. The 10½ in. x 5¼ in. bloom is cut down to 5 in. web thickness in the first time through the first groove and in the second time through down to 2½ in. web. The bar is then turned over and run through the second groove and then on to the three-high finishing mill where the beam is given 7 passes. The beam on leaving the two-high mill is not turned over, being too long for turning.

4 IN. BEAM

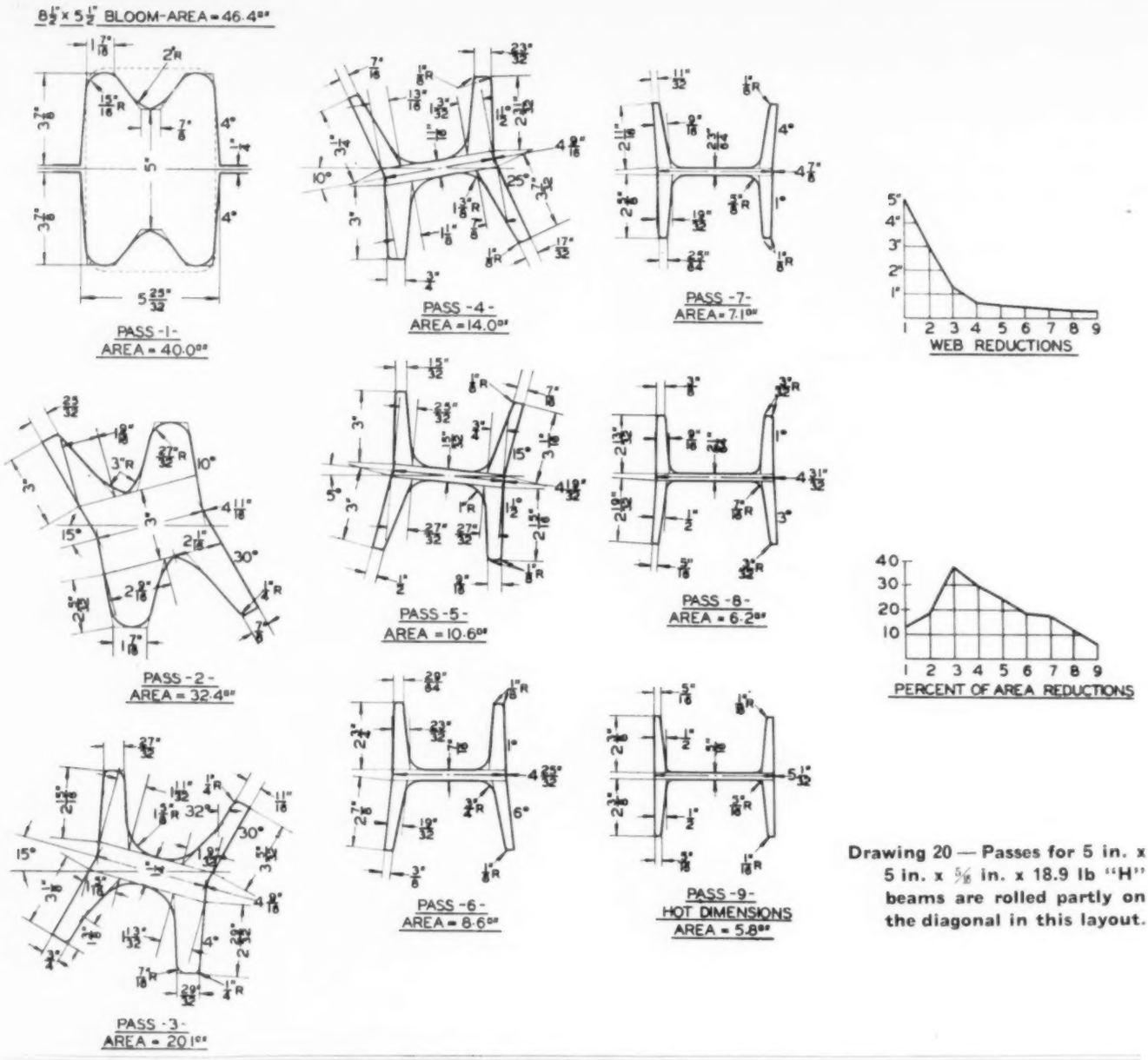
The 4 in. beam design shown on Drawing 11, Figure 1, is one rolled on the 24 in. and 21 in. cross-country mill shown on Drawing 5. There are nine shaped passes and the first pass of the ten pass mill is a slab pass. This 4 in. standard beam has thin flanges and the flange draft must be light because of this thinness. The amount of draft on the live flange of the finishing groove is $\frac{1}{32}$ in. smaller beams must be proportioned so that there will be no excessive spread that will cause loss of flange height and still have enough spread to prevent shearing on the sides. A beam of this size is relatively easy to produce providing the first passes are correctly filled. This is the only difficult part.

In talking of the larger beams it was mentioned that the dead holes were usually well filled. In the smaller size beams made with this type design the dead hole in



Drawing 19 — Passes for 5 in. special "H" beams.

while the dead flange has a scant $\frac{1}{64}$ in. From the finishing back to the first pass the drafts are gradually increased. The dead flanges entering the live holes are made long to allow for the drawing down of flange length as in the larger beams. The spread in these small beams must be more carefully proportioned than in the larger beams. One of the ways of determining spread is shown in Figure 2 of the drawing. This shows a beam entering a pass and how far it enters. The sketch shows how this method is employed to determine the width of the leader web which by this scheme is set at a spread of $\frac{5}{64}$ in. from the leader to the finishing, as measured in the center of the web. The further the pass is entered the greater the spread will be. The widths on these the first pass is hard to fill. In the first groove of this design the dead flanges are drawn considerably shorter than the live ones because if made longer they would be badly underfilled. The 7½ in. x 3¼ in. slab on edge entering the first shape pass resists being forced down into the dead grooves and the metal flows to fill the top flanges which are long. In the second pass the bottom flanges are cut in by the tongue roll which is fairly sharp, and the top flange is fully filled because of plenty of flange furnished in the first pass. When these first two passes are well filled there will be no trouble with underfilled flanges in the finishing passes. The reduction in the first two passes is heavy. The 7½ in. x 3¼ in. bloom is reduced to 3¼ in. web in the first pass and to 1½ in. in



Drawing 20 — Passes for 5 in. x 5 in. x 5/16 in. x 18.9 lb "H" beams are rolled partly on the diagonal in this layout.

the second, and only slow moving heavily ragged rolls will pull this kind of draft.

The 4 in. beam took 9 shaped passes to produce. On Drawing 12 is shown a 7/8 in. x 5/8 in. x 5/64 in. beam as rolled on a 9 in. hand bar mill in five shaped passes. This design points out the fact that small shapes are more readily formed than large ones and in fewer passes, owing to the greater spread as compared to elongation found in forming smaller shapes. Many intricate shapes which it would be impossible to roll in large sizes on existing mills are readily formed in small sizes.

STANDARD MILLS WITH UNIVERSAL STANDS AND DIAGONAL PASS DESIGN

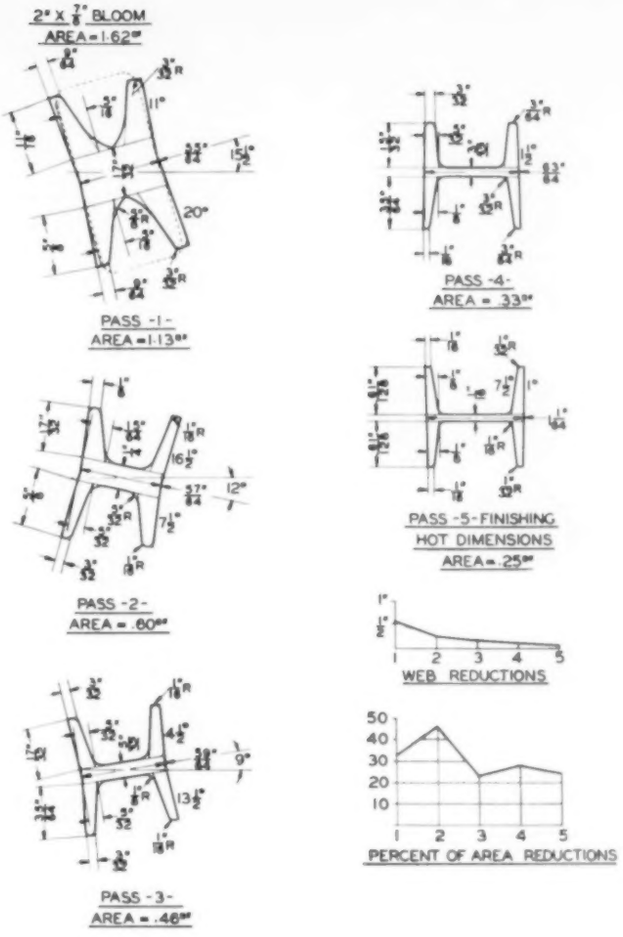
Standard beams as rolled on two or three-high standard structural mills, such as previously described, are usually confined to flange widths of about 8 in. and to a depth of 27 in. In addition, they must have a substantial flange taper. Mill roll diameters are limited in size and this restricts the overall width of flange that can be rolled.

The limitations in the size of beams which could be obtained from existing mills was apparent early. Beams with parallel flanges were desired in building construction but there were no mills capable of rolling them. Although the universal beam mill was developed around 1860, and one in France rolled a 43 in. beam in 1867, the mills were generally expensive to build in large sizes and other less expensive means were devised to roll the small tapered beams. In 1876 Joseph De Buigne developed diagonal rolling for beams using some of the features previously developed for the rolling of tees, see Drawing 13, Figure 1, for some finishing mill passes. The tees had been rolled with each leg 120 degrees from the others and two flanges were rolled while the other was drawn through a dead groove. After each pass the tee was turned 120 degrees, thus alternating the work on the members, and when sufficiently rolled the tee was straightened in the finishing pass. This type of rolling was applied to beams (see Figure 2) and De Buigne rolled the first "H" beams 3.15 in. x 3.15 in. in size in 1876.

Drawing 14 shows this diagonal beam design, first developed by De Buigne, as used in combination with a universal finishing stand in a German plant. The drawing shows the layout of the roll stands. In the roughing and intermediate stands the passes were on the diagonal and had inside flange tapers of approximately 8 degrees. The rolls were two-high and after each pass the bars were returned over the top roll for further passes. The universal finishing stand which finished the beams had hand operated screws for changing drafts, the top roll and the side rolls being adjustable while the bottom roll was stationary. One or more passes were made in this stand which straightened up the flanges while rolling off most of the 8 degree taper and produced a nearly parallel flange. The lengths were limited to about 30 ft as iron piles were used for stock. The universal mill stand was similar to the one designed by Pernot in 1866.

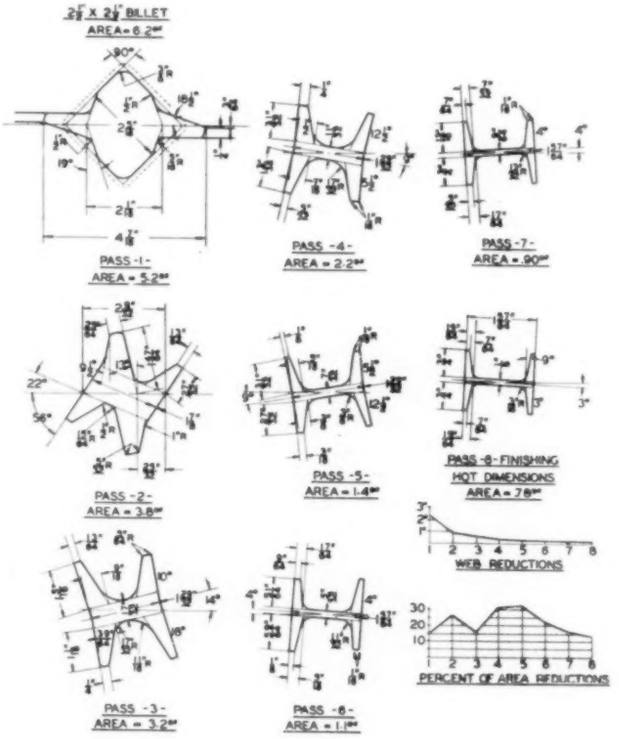
Another early mill design for the rolling of small tapered beams is shown on Drawing 15, Figure 1. This layout had four roll stands. The 25⅝ in. three-high roughing was driven independently and the 22 in. mill of two three-high stands and one two-high stand in line was driven by a belt from the roughing engine. In this mill the separate three-high roughing shaped the beam by the diagonal method while the two three-high stands of the finishing mill were set up as shown in Figure 2 with the universal mill pass in the middle and bottom roll and the edging passes between the middle and top rolls. The finishing stand had a four roll universal stand which straightened up the flanges.

While this type of rolling produced beams with parallel, or nearly parallel flanges, it did not do away with the stretching of the flanges received in the dead holes in the early roughing passes.



Drawing 22 — Passes for 1 in. x 1 in. x ⅛ in. beams.

Drawing 21 — Passes for 1⅞ in. beams.



MILLS FOR SMALLER SHAPES

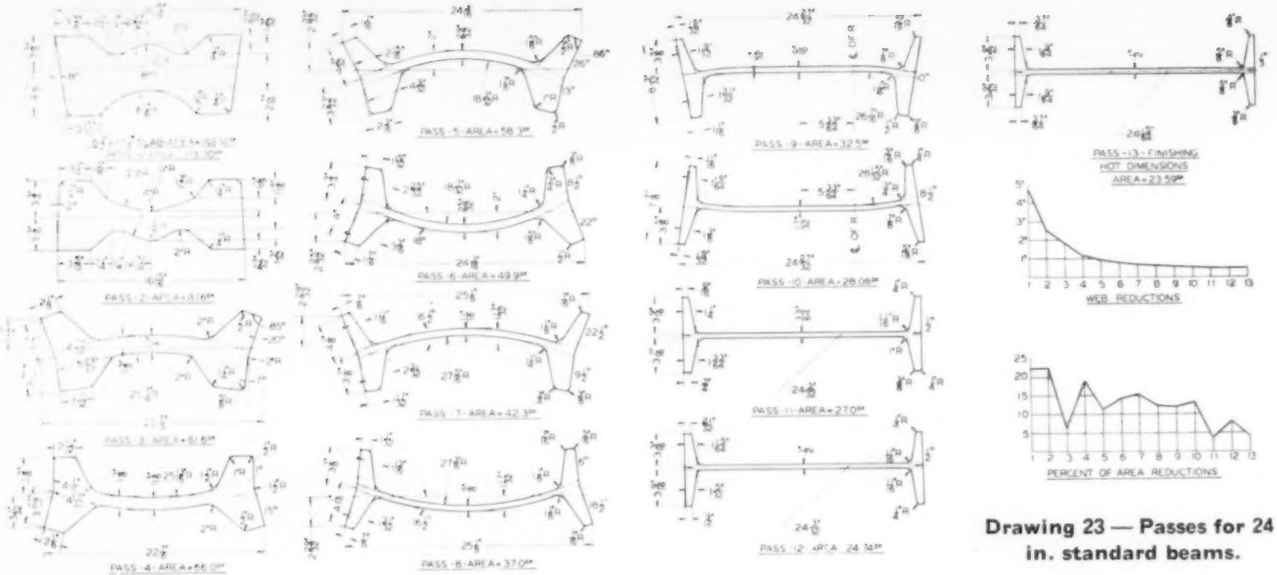
The small sizes of beams and channels of our modern times are usually produced on the smaller types of standard structural mills, as for instance the cross-country mills previously shown or on merchant bar mills similar to the ones shown on the following drawings.

Drawing 16 shows a 14 in. merchant bar mill of the cross-country pattern with a semi-continuous roughing and a layout of finishing stands which is called a staggered duo design.

Of the six roughing stands, stands 1 and 2 are free stands; i.e., they are not continuous. Stands 3-4-5 and 6 are continuous, though the bars run out free from stands 4 and 6. Stands 7-8-9 and 10 are free. The bar reverses ends in each of these last 4 stands; i.e., the last end out is the first end in. Mills of this type roll shapes of the smaller sizes and bars also.

The advantages of a mill of this kind are numerous, one of these is fast passage through the roll, insuring hot delivery. Another is the long lengths which may be rolled. High tonnages of comparatively light sections are produced.

Drawing 17 illustrates another type of cross-country



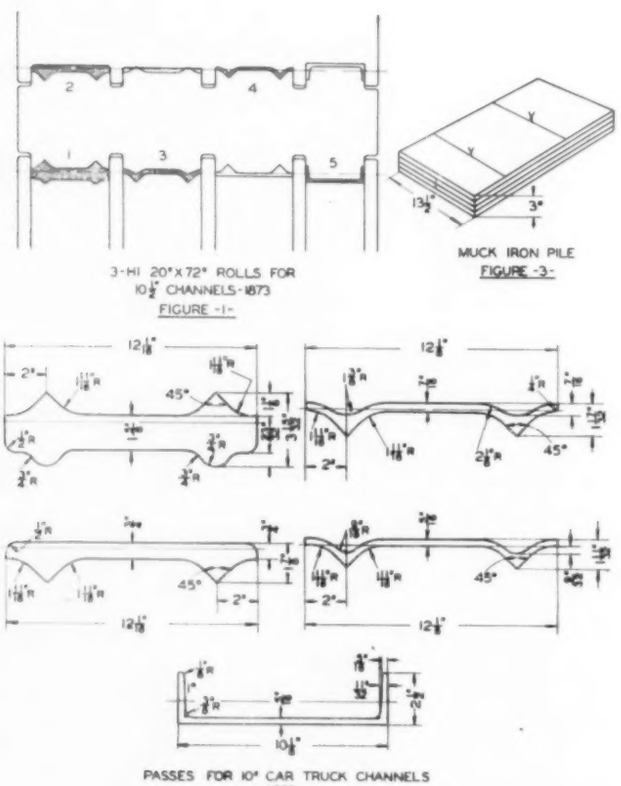
Drawing 23 — Passes for 24 in. standard beams.

bar mill. This 12 in. mill has a four stand continuous roughing, and following this four cross-country stands of rolls. Passes 6 and 7 and 8 and 9 are rolled in three-high stands, all others are in two-high stands. Some of the smaller sizes of beams and channels are rolled on this mill.

Drawing 18 shows a 9 in. hand operated bar mill, a type of mill well adapted to rolling small shapes. On this mill many sizes of window sash, angles, small beams and channels and a variety of small shapes were rolled.

The diagonal rolling system for beams is still in use in these modern times and is used for beams with large flanges and for flanges of small inside taper.

Drawing 24 — Channel rolled at Upper Union Iron Mills in 1873.



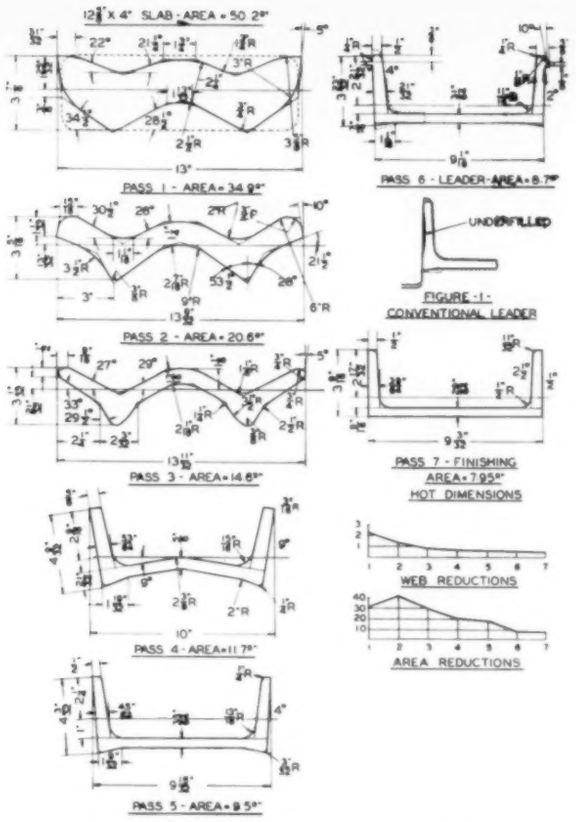
In the design first developed by De Buigne the live flanges were rolled, while the dead flanges rode free in the pass and were not worked. In the modern layouts a small amount of side work may be used in the dead holes in the roughing passes, and the ends of the flanges are reduced in length in all dead passes.

Drawing 19 shows a 5 in. special "H" beam design in which all the passes are diagonal, except pass 1 which is slightly formed and straight. The inside taper of the flange of this beam is less than 5 degrees as compared to the 9½ degree taper of a standard beam. This design is used on the cross-country mill shown on Drawing 5.

In the several last pass drawings of this beam, the live hole flange entering the dead flange is drawn with less thickness than the pass it enters. This is because there is considerable spring in the rolls of the mill on which this section is produced, and such spring will cause the live flange to become thicker than shown on the drawing. The live flange is made thinner than the dead pass to allow for this.

Figure 2 of this drawing shows a part of the rolls for this section called a bearing collar. The draft on the live holes with a diagonal pass of this kind is applied in such a manner as to cause a heavy side thrust, as indicated by the arrows in the figure. The result of this thrust is that the bottom roll tries to shift to the left and the top roll to the right, and if the rolls were not kept from doing this, the live flanges would become considerably thicker than designed. The bearing collar prevents this side movement. The bearing collars, unless kept oiled or greased, will wear during a rolling and allow the rolls to shift sideways and further increase the live flange thickness. In a design of this kind the live flange, if much thicker than the dead hole it enters, will not fill the dead hole. It will be wedged in and will not go to the bottom of the pass. In so doing it will push the dead flange up higher as it is being rolled in the live flange groove and will cause an overfill as shown in Figure 3. To prevent such an occurence the live flanges in some designs are made somewhat thinner than the dead holes they enter.

One of the objects of rolling beams on the diagonal is to produce long flanges, and the live flanges, being flared out, offer a more direct rolling action and favor


PASS 1 - AREA = 34.9"
PASS 6 - LEADER - AREA = 8.7"
UNDERFILLED
FIGURE -1-
CONVENTIONAL LEADER
PASS 2 - AREA = 20.6"
PASS 7 - FINISHING
AREA = 7.95"
HOT DIMENSIONS
PASS 3 - AREA = 14.8"
WEB REDUCTIONS
AREA REDUCTIONS
PASS 4 - AREA = 11.7"
PASS 5 - AREA = 8.5"

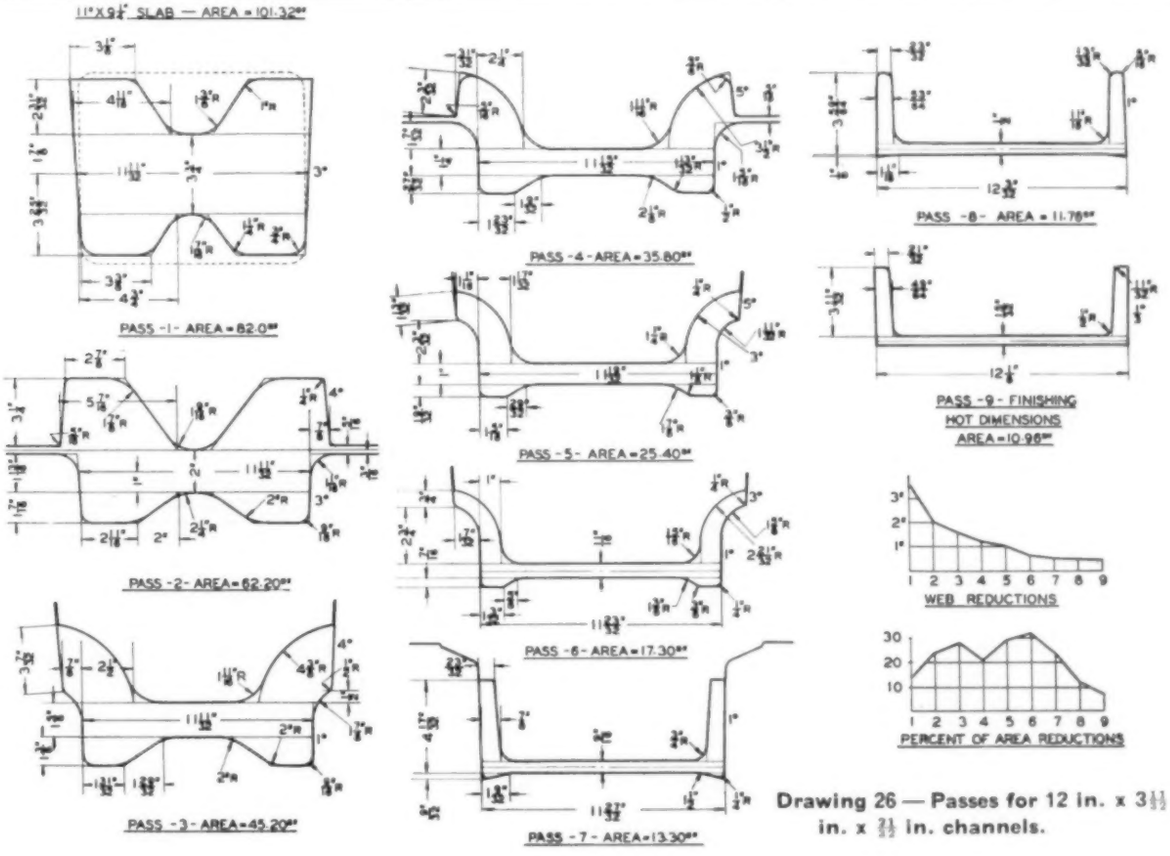
Drawing 25 — Passes for 9 in. x 3.5 in. x 0.45 in. x 25.4 lb channels shown are a modern butterfly type.

the production of long flanges. In the rolling of beams by the straight method, as discussed in the first part of this paper, the dead flange entering the following live flange is made longer than the live one to allow for choking and drawing down in length. In the diagonal method there is little or no drawing down of flange length in the live grooves. The flared out position of the live flanges offers an opportunity for a good rolling and spreading action and there is practically no loss of flange height. The live flanges entering the dead grooves have a tendency to push up out of the dead groove and hold the opposite flange up and allow a good spreading action in this part.

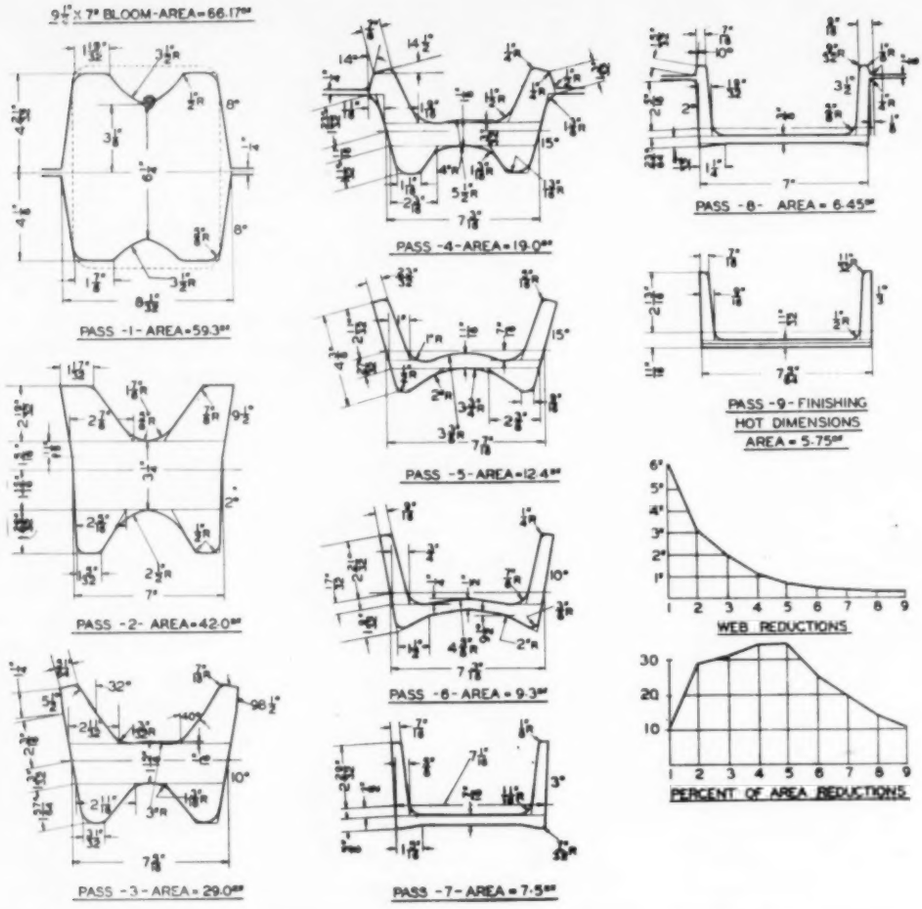
With this style of working, only one foot weight can be rolled correctly as the necessary raising and lowering of the rolls for other weights alters the dimensions of the flanges on the live holes and also the depth dimension, while the dead flange remain unchanged.

Drawing 20 shows still another design rolled on the mill shown on Drawing 5, a design which is partly on the diagonal, the roughing passes being diagonal and the finishing passes straight. This design is also of a 5 in. "H" beam of different dimensions from the one just discussed. With this layout several foot weights may be rolled as the finishing mill passes are not on the diagonal and the raising and lowering of the rolls does not change the live flange thickness or the beam depth to any appreciable extent. The diagonal roughing passes are not raised.

Drawing 21 illustrates still another design for a 1⅞ in. small beam suitable for rolling on the smaller mills which have been shown. In this design, a 2½ in. billet is entered diagonally into a pass, the shape of which is such as to cause two of the billet corners to spread freely to form two flanges. The second pass is so designed as to spread the other two billet corners and form the other two flanges, and the beam shape is then developed,


11" X 9 1/4" SLAB — AREA = 101.32"
PASS -1- AREA = 82.0"
PASS -2- AREA = 62.20"
PASS -3- AREA = 45.20"
PASS -4- AREA = 35.80"
PASS -5- AREA = 25.40"
PASS -6- AREA = 17.30"
PASS -7- AREA = 13.30"
PASS -8- AREA = 11.75"
PASS -9- FINISHING
HOT DIMENSIONS
AREA = 10.98"
WEB REDUCTIONS
PERCENT OF AREA REDUCTIONS

Drawing 26 — Passes for 12 in. x 3 11/32 in. x 21/32 in. channels.


9½" x 7" BLOOM - AREA = 66.17"²
PASS - 1 - AREA = 59.3"²
PASS - 2 - AREA = 42.0"²
PASS - 3 - AREA = 29.0"²
PASS - 4 - AREA = 19.0"²
PASS - 5 - AREA = 12.4"²
PASS - 6 - AREA = 9.3"²
PASS - 7 - AREA = 7.5"²
PASS - 8 - AREA = 6.45"²
PASS - 9 - FINISHING HOT DIMENSIONS AREA = 5.75"²
WEB REDUCTIONS
PERCENT OF AREA REDUCTIONS

Drawing 27 — Passes for 7 in. x 3½ in. x $\frac{11}{32}$ in. x 19.1 lb channels shown are all live ones.

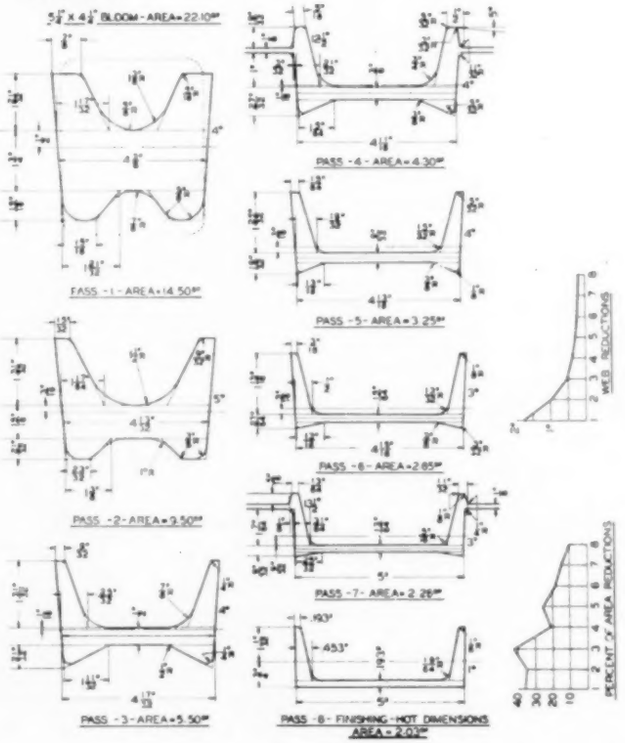
after which procedure the diagonal passes further roll the beam to the finished size in a total of eight passes. This is one of the favored designs for small beams as rolled on bar mills. The mill this section was rolled on has very little spring in the rolls and the flanges have a good inside taper so it is not necessary to make the live flanges thinner than the dead holes they enter.

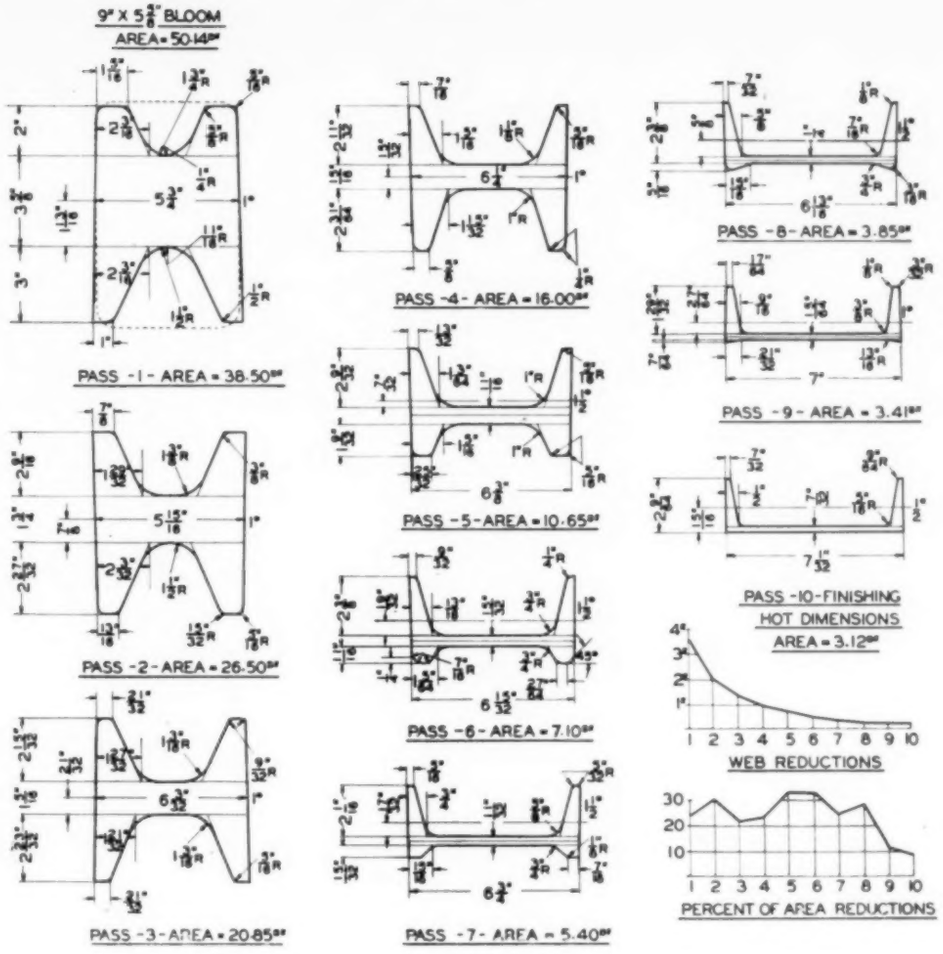
Drawing 22 illustrates the pass design for a very small "H" beam 1 in. x 1 in. x $\frac{1}{16}$ in. in size as rolled on the 9 in. hand bar mill shown on Drawing 18. Of the five passes used, three are diagonal and two are straight. This design illustrates the point which has been discussed previously that small sections can be produced in fewer passes than larger ones. A section as small as this must be rolled in fairly short lengths and very quickly to maintain the heat in the bar.

As has been seen in the designs shown and learned from the discussion, the diagonal position of flanges permits some spreading action and favors flange length. This principle has been known for many years and many designs have been projected to take advantage of this rolling action.

One of the more original efforts in this line is shown on Drawing 23. This illustrates a design for a 24 in. standard beam. The designer's plan was to roll the beam from a rectangular bloom or slab, thus obviating the use of a beam blank. The first two passes, working over each other to conserve roll space, were designed to start the shaping of the web and flanges. Passes 3 and 4 also worked over each other and provided a reverse bending action of the web and alternate flaring out of the flanges so that a spreading action could be had in the live holes. This same procedure was continued in passes 5, 6, 7, 8, 9, and 10. In pass 11 the flanges and web were straightened and the beam finished in the conventional way in passes 12 and 13. The section was

Drawing 28 — Passes for 5 in. x 1¾ in. x 0.19 in. x 6.7 lb channels.


5¼" x 4¼" BLOOM - AREA = 22.10"²
PASS - 1 - AREA = 14.50"²
PASS - 2 - AREA = 9.50"²
PASS - 3 - AREA = 5.50"²
PASS - 4 - AREA = 4.30"²
PASS - 5 - AREA = 3.25"²
PASS - 6 - AREA = 2.65"²
PASS - 7 - AREA = 2.28"²
PASS - 8 - FINISHING - HOT DIMENSIONS AREA = 2.03"²
WEB REDUCTIONS
PERCENT OF AREA REDUCTIONS


9" x 5 3/8" BLOOM
AREA = 50.14"²
PASS -1- AREA = 38.50"²
PASS -2- AREA = 26.50"²
PASS -3- AREA = 20.85"²
PASS -4- AREA = 16.00"²
PASS -5- AREA = 10.65"²
PASS -6- AREA = 7.10"²
PASS -7- AREA = 5.40"²
PASS -8- AREA = 3.85"²
PASS -9- AREA = 3.41"²
PASS -10- FINISHING
HOT DIMENSIONS
AREA = 3.12"²
WEB REDUCTIONS
PERCENT OF AREA REDUCTIONS

Drawing 29 — This pass design for 7 in. x 2.09 in. x 0.21 in. x 9.8 lb channels is one of the more commonly used methods.

designed for a four stand in line three-high mill which is now obsolete.

This design was used in rolling beams but it was soon discontinued for various reasons, one of which was the difficulty of making the reverse bends of web and flanges and keeping the beam in line in the passes.

FOOT WEIGHTS

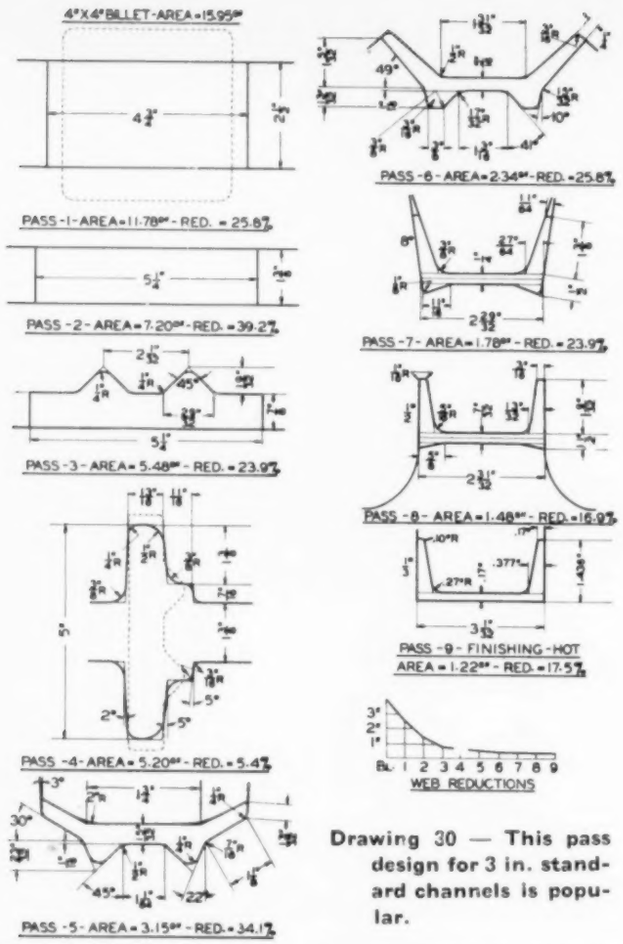
In the layout of a beam rolled by the straight method the passes are usually designed for the lightest foot weight rolled. The weight increase in beams is all taken in an increased web thickness which, in addition, gives an overall flange increase. In raising the rolls for the heavy foot weights the finishing and leader rolls are raised the full amount of the web increase but the roughing passes are not raised by the same amount as a decrease in web draft reduces web elongation and allows the flanges a better opportunity to fill. The dead holes will roll off any excess flange length and the flanges thus have a better appearance. There is no perceptible increase in the flange thickness above the web for the heavier foot weights and all the weights may be made in the same grooves. In the completely diagonal system of rolling, only one foot weight may be rolled true to dimensions. The handbook of any structural steel company will give the foot weight dimensions of the various sections; consequently, it is unnecessary to show all of them here.

CHANNEL DESIGN

Rolled channels were developed at about the same time as beams, but in the early literature there is not a great deal said about the rolling of channels. It is thought that channels were first produced by rolling off the lower flange of the beam, much the same as done in some designs today. The same type of mills were used for the rolling of channels as for beams and, in modern times, it is still common practice to use the forming passes for beams for the rolling of channels, though there are other ways of producing a channel.

Andrew Kloman, one of the builders of the Union Iron Mills of Pittsburgh and an early partner of Andrew Carnegie, was a first class engineer and mechanic, and it is said that among his accomplishments was the ability to design rolls for shapes. In the roll designs of the Union Iron Mills in 1873 we find an example of what was said at that time to be a new way of rolling channels. Drawing 24, Figure 1, illustrates this design, a butterfly method of rolling. It is believed that Andrew Kloman had a hand in this design. The name butterfly design comes from the fancied resemblance of the bent out flanges to the wings of a butterfly. The section is said to have worked well on the first trial. The flanges were practically parallel on this 10½ in. size. The stock used was an iron pile composed of puddle bar flats.

In 1876 this same company made a 10 in. car truck channel by this same butterfly method, showing that the design of 1873 was a useful one and had been con-


4"X4" BILLET - AREA = 15.95in²
PASS - 1 - AREA = 11.78in² - RED. = 25.8%
PASS - 2 - AREA = 7.20in² - RED. = 39.2%
PASS - 3 - AREA = 5.48in² - RED. = 23.9%
PASS - 4 - AREA = 5.20in² - RED. = 5.4%
PASS - 5 - AREA = 3.15in² - RED. = 34.1%
PASS - 6 - AREA = 2.34in² - RED. = 25.8%
PASS - 7 - AREA = 1.78in² - RED. = 23.9%
PASS - 8 - AREA = 1.48in² - RED. = 16.9%
PASS - 9 - FINISHING - HOT
AREA = 1.22in² - RED. = 17.5%
WEB REDUCTIONS

Drawing 30 — This pass design for 3 in. standard channels is popular.

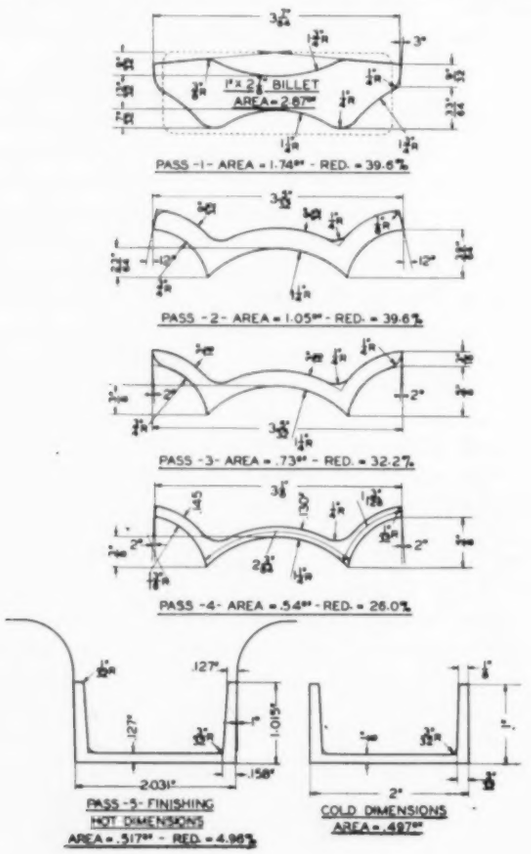
tinued. Drawing 24, Figure 2, shows the dimensioned passes for this size channel, and in Figure 3 you may see the pile of puddle iron used in rolling the section.

This style of rolling has continued in a modified form to this day, and Drawing 25 illustrates a 9 in. car and ship building channel rolled by the modern butterfly system on mills similar to those shown on Drawings 2 and 3. This design is very useful for channels which have a small taper on the inside of the flange. The nearly flat position of the flanges in the roughing passes permit rolling the flange close to the finished thickness before bending to the final shape. This style of rolling is also beneficial to the steel as the flange gets almost as much flat rolling as the web and has about the same tensile strength.

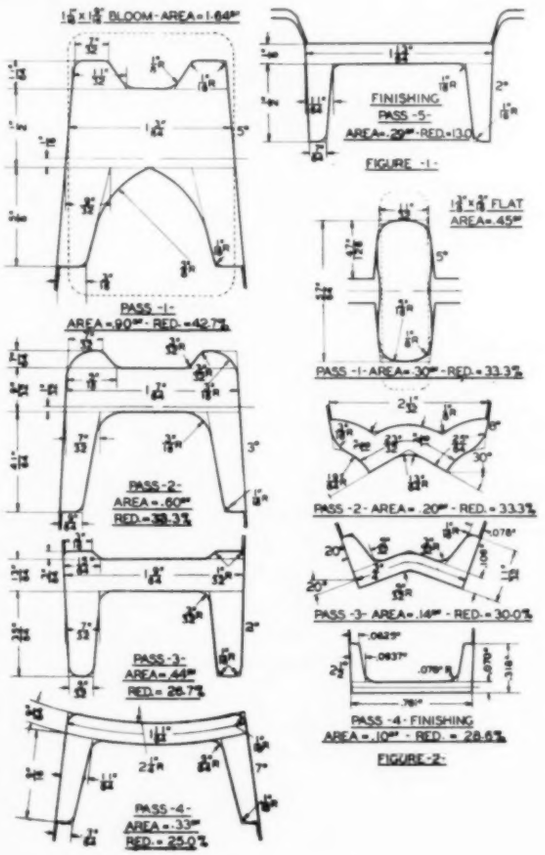
In this layout the leader pass is practically a live hole differing from the conventional leader pass which is illustrated in Figure 1 of this drawing. In the conventional type leader pass the entering flange, as shown by the dotted lines, is usually kept thinner than the pass it enters for various reasons, one being that there is a limited taper on the flanges which is apt to cause the flange entering the dead hole to cling to the sides of the pass and break the delivering flange guide and cause a collar on the roll. Another objectionable feature in the conventional design is that the entering flange, being thinner, does not fully fill the dead hole, except on the flange end and at the base where it is joined into the web. This in turn causes the finishing flange to be underfilled in the middle.

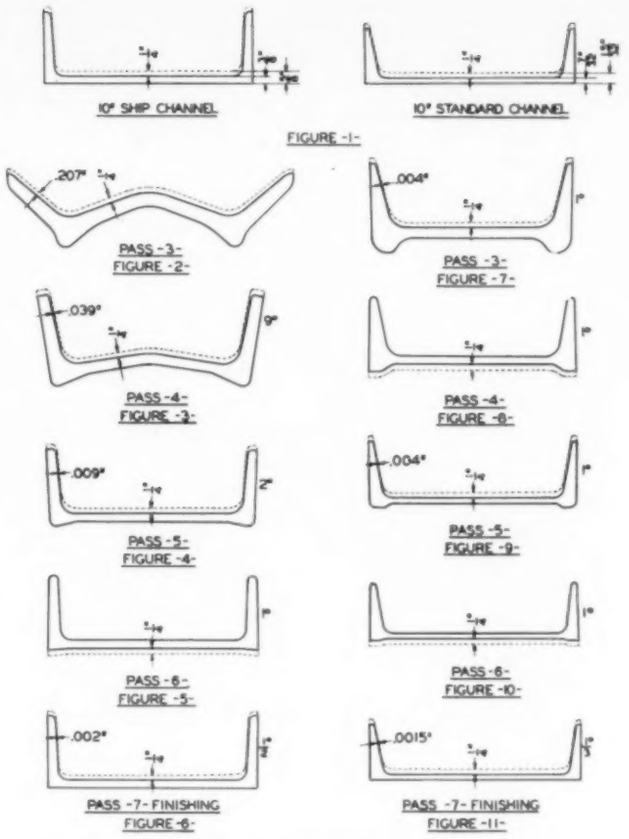
The live flange design, as shown in this 9 in. section,

Drawing 31 — Passes for 2 in. x 1 in. x 1/8 in. channels.


1" x 2 1/8" BILLET
AREA = 2.87in²
PASS - 1 - AREA = 1.74in² - RED. = 39.6%
PASS - 2 - AREA = 1.05in² - RED. = 39.6%
PASS - 3 - AREA = .73in² - RED. = 32.2%
PASS - 4 - AREA = .54in² - RED. = 26.0%
PASS - 5 - FINISHING
HOT DIMENSIONS
AREA = .517in² - RED. = 4.96%
COLD DIMENSIONS
AREA = .497in²

Drawing 32 — Passes for 1 3/16 in. x 5/8 in. and 3/4 in. x 5/16 in. channels.


1 5/8" x 1 3/8" BLOOM - AREA = 1.64in²
PASS - 1 -
AREA = .90in² - RED. = 42.7%
PASS - 2 -
AREA = .60in²
RED. = 38.3%
PASS - 3 -
AREA = .44in²
RED. = 26.7%
PASS - 4 -
AREA = .33in²
RED. = 25.0%
FIGURE - 1 -
FINISHING
PASS - 5 -
AREA = .29in² - RED. = 13.0%
1 3/4" x 5/8" FLAT
AREA = .45in²
PASS - 1 - AREA = .30in² - RED. = 33.3%
PASS - 2 - AREA = .20in² - RED. = 33.3%
PASS - 3 - AREA = .14in² - RED. = 30.0%
PASS - 4 - FINISHING
AREA = .10in² - RED. = 28.6%
FIGURE - 2 -



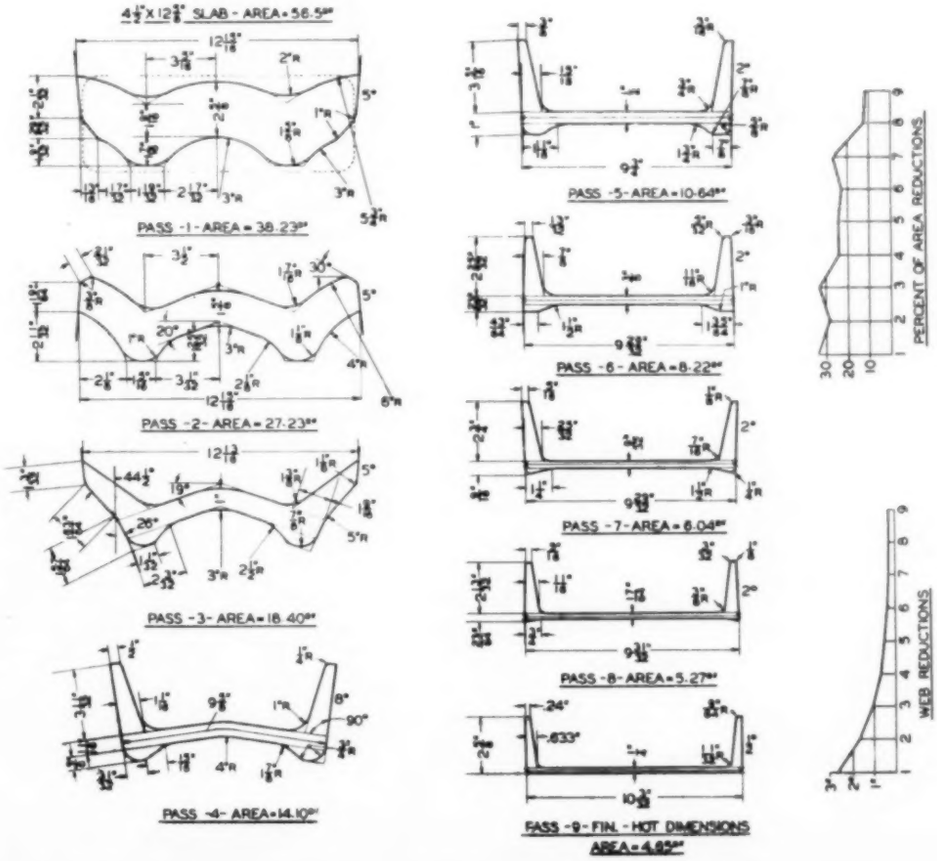
Drawing 33 — Effect of raising rolls for weight increase in butterfly and straight methods.

does fill perfectly as there is some side work given and there is no underfilling of the finished flange. In addition, with this design there is a rather light pressure on the delivering flange guides and they last longer and deliver the flange better.

There are many ways to arrive at the solution of rolling problems. As an illustration, Drawing 26 shows an unusual design for a 12 in. car truck channel. In this layout a slab is used for stock. In the first pass the web is cut in and the formation of the flange is started and in the next three passes the flange, as formed in the first pass, is bent and flared out. In the following two passes the bent flange is spread and lengthened. In the seventh pass the flange is bent up straight. The bending out of the flange is done so that a more direct rolling and spreading action can be given on this part. In the eighth pass the flange is edged for uniformity of length and finished in the ninth pass. This channel was rolled on a 35 in. mill. There is no particular merit in rolling this channel in this way as it could be rolled in the same manner as the one just described but it serves as an illustration of one of the ways a channel may be produced.

Drawing 27 illustrates still another way of making channels. In this 7 in. ship channel design all the passes are live ones. A 9½ in. x 7 in. rectangular bloom is used. The fourth pass edges the flange down in a pass where the roll opening is near the top and on the side. The flange is not edged again until the eighth pass which is the leader. This type of design is useful for channel sections where, for various reasons, it is not desired to use the butterfly design.

Drawing 28 shows a 5 in. standard channel design where the passes are all live. This is rolled in a manner very similar to the 7 in. channel just described. This method of working eliminates dead holes and the wire drawing and stretching the flanges receive in them. Among other advantages of the layout, it practically



Drawing 34 — Butterfly design for 10 in. x 2.6 in. x 0.24 in. x 15.3 lb standard channels.

eliminates the guide trouble encountered in the hanging flange guides used in the dead holes of the designs which have alternate live and dead holes, and in which the dead flange guides are frequently bent and broken by the heavy pressure of the bar on the guides.

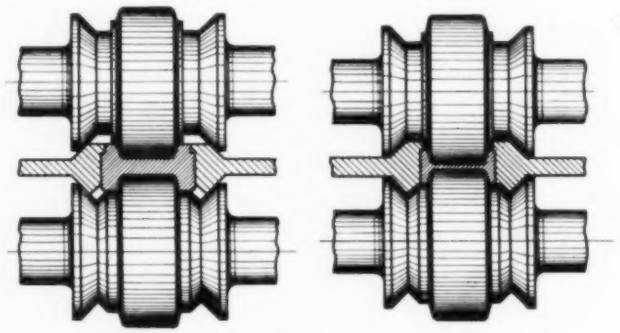
Drawing 29 shows a design for 7 in. standard channels in which the early passes for 7 in. beams are used to start the formation. After the fourth pass, which is common to beams and channels, the bottom flanges of the produced beam shape are rolled off in a series of live and dead grooves. In the dead holes the flanges are more or less wire drawn, due to the small amount of side work in these grooves. This design is one of the commonest ways to produce channels.

On Drawing 30 is shown a design for a 3 in. standard channel used on mills where there is a continuous roughing. Passes 1 and 2 are plain slabbing passes. Pass 3 has two grooves designed to form the channel corners. Pass 4 is used to edge and regulate the bar to the proper width to enter pass 5 where the flanges are partly bent up. Passes 6 and 7 further bend the flanges up to a point where they can enter the leader, which is a dead hole, and then the channel is finished in pass 8. In this design passes 1, 2 and 4 may be used for more than one size of channel and the design is popular for these reasons.

Drawing 31 shows the passes for a 2 in. channel, with $\frac{1}{8}$ in. thick flanges and web, rolled with a butterfly design and bent straight in the finishing pass. This channel was rolled on a 9 in. Belgian type bar mill.

Drawing 32. Figure 1, illustrates the passes for a $1\frac{3}{16}$ in. special channel rolled on the 9 in. Belgian type bar mill. The section is rolled with the flanges down in dead holes so that the overall flange height will be constant and resting flange guides may be used throughout.

Figure 2 of Drawing 32 shows a $\frac{3}{4}$ in. special channel rolled in three shaped passes. In the previous design the leader pass being straight is inclined to wear wide owing to the small taper on the sides. In the design we are discussing, the two passes before the finishing are of the butterfly shape and can be returned to the original widths with very little roll reduction at each dressing. The formation of this channel is started with a flat $1\frac{3}{8}$ in. x $\frac{5}{16}$ in. in size which is entered into a round edging pass as shown. The bar out of this edging pass is $\frac{57}{64}$ in. x $1\frac{1}{32}$ in. in size and is entered into the first shape pass and held in exact position by a guide box.



2-HI OPEN — FIGURE - 1 — 2-HI CLOSED

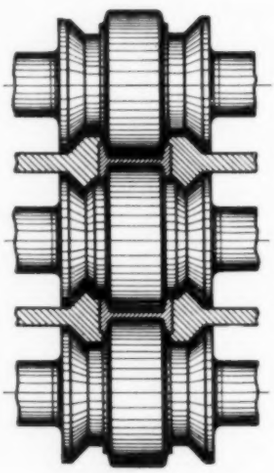


FIGURE - 2
3-HI CLOSED

Drawing 36 — I. L. Seaman designed this universal mill in 1883.

Drawing 35 — Early universal beam mills.

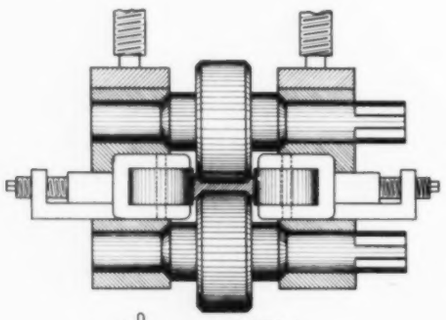


FIGURE-1
PETIN-GOUDET'S UNIVERSAL BEAM MILL OF 1860

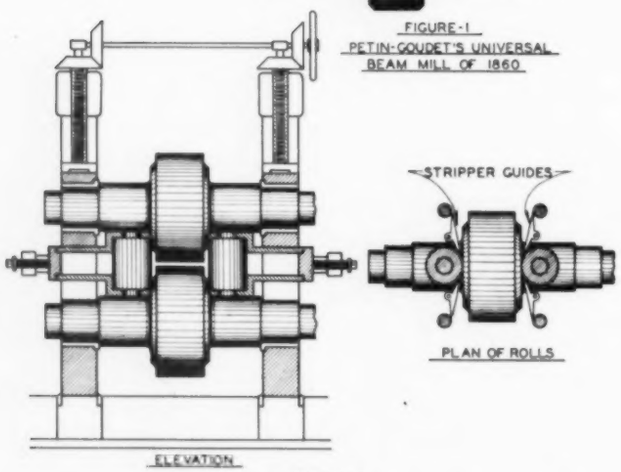
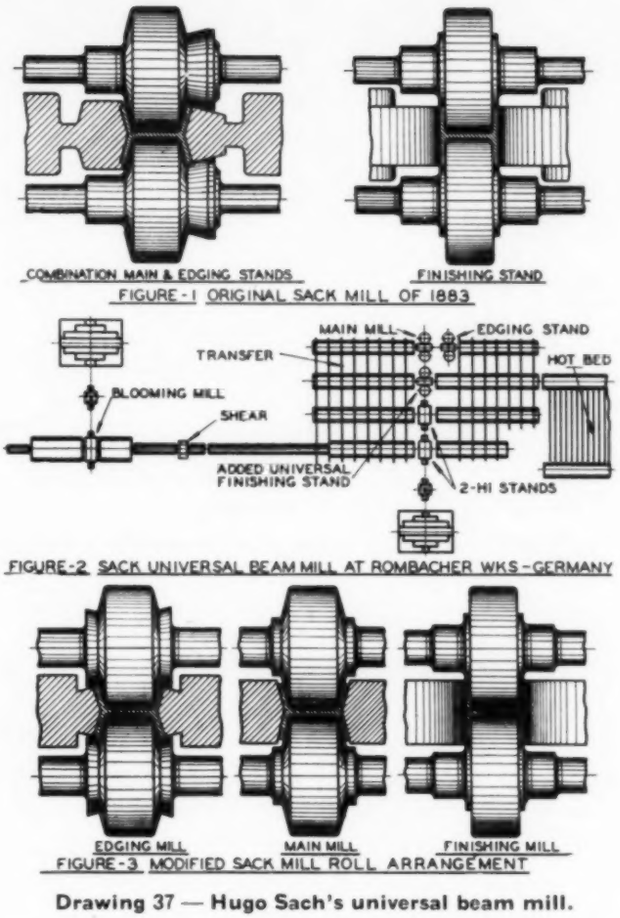


FIGURE - 2
PERNOT'S UNIVERSAL BEAM MILL OF 1866

The butterfly designs for the large size channels are used mostly for those channels that have a minimum of flange taper and usually these channels do not have as many weight differences as standard channels. A large spread between the lightest and heaviest weights causes trouble with the butterfly system of rolling channels. Drawing 33 shows some figures which illustrate undesirable features of the design when rolling heavy foot weights in the same grooves as used for the light weight.

The weight increase for all types of channels is obtained by an increased web thickness as shown in Figure 1. This web increase thickness also increases the overall flange width.



Drawing 37 — Hugo Sach's universal beam mill.

In Figure 2 of this drawing, which shows a butterfly channel pass, it will be noted that an increase of ¼ in. in the web thickness of this pass increases the flange thickness by 0.207 in. In Figure 3, the pass following, a web increase of ¼ in. means only a flange increased thickness of 0.039 in. In Figures 4, 5, and 6 the flanges have been straightened and web increases do not affect flange thicknesses appreciably. This means that if the roughing passes are raised excessively, a large extra flange reduction is carried on to the pass shown in Figure 3, and in many cases this will cause overfills and shearing.

In contrast to the butterfly scheme of rolling, the straight flange system as used for most standard channels is illustrated in Figures 7, 8, 9, 10, and 11. Here you will note that a web increase does not appreciably affect the flange thickness in any of the passes and large spreads of foot weight between the lightest and heaviest section may be rolled without trouble. As most standard channels do have considerable variations in foot weight they are rarely produced by the butterfly system.

On Drawing 34 is shown a butterfly design for a 10 in. standard channel which permits rolling the full range of foot weights satisfactorily. The weights range from 15.3 lb to 30 lb with a web increase of 0.233 in. By using nine passes to produce the section and using a 4½ in. x 12⅝ in. slab for stock, it is possible to bend the flange straight in the fifth pass, with four more passes left to finish the section. These extra passes mean that the butterfly roughing passes need not be raised the full 0.233 in. for the heaviest section. The finishing and leader passes are raised the full amount, but from there on back a diminishing amount of web work is given so that in passes 3 and 4, a ⅛ in. raise in web is all that is necessary and the extra flange thickness consequent to this extra web thickness does not cause an excessive side flange draft in pass 4. All the foot weights are rolled satisfactorily in the same grooves by this design.

UNIVERSAL BEAM MILLS

Earlier in the discussion, the development of the "H" beam and the smaller sizes of the parallel flange beams as rolled on the two-high and three-high mills was traced, and also the use of various types of four roll universal type mill stands to finish the beam.

These mills, while fairly satisfactory, were not the ultimate in universal beam mill design. The flanges of the beams as rolled in the preparatory passes were not drafted as well as the web and the beams were limited in size.

The desire for beams of greater depth with thinner webs and larger flanges with little or no taper spurred on the inventive minds of the engineers to solve the problem and it may prove interesting to trace the development of their ideas.

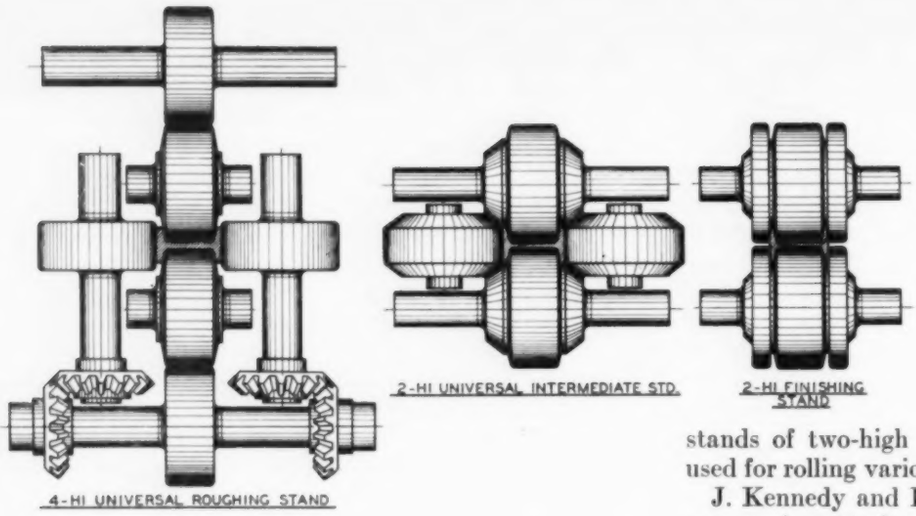
One of the first mention of a beam being rolled in a universal mill was in 1854 when the Trenton Iron Co. designed a universal type mill and rolled a 7 in. deep beam. Further mention is found in France when in 1860, the firm of Petin-Goudet & Co. used a universal mill to roll beams and channels. The French design is shown on Drawing 35, Figure 1, and this mill shows some of the features of our more modern designs.

Pernot's design of 1866 is shown in Figure 2. This design was used as a finishing stand in connection with two-high and three-high standard mills. Note the stripper flange guide in the plan view.

In 1867 a new universal beam mill of a French company is said to have rolled beams 43.307 in. in depth and 13 ft long. The ingot was cast in a rough beam shape for this rolling.

In 1883, L. Seaman of the roll making firm of Seaman-Sleeth of Pittsburgh applied for a patent on a universal beam mill. This mill is shown in Figure 1 of Drawing 36. This design required the turning over of the beams after each pass to edge overfills off the flanges and regulate the flange length. An alternate proposal of Seaman's is shown in the three-high design where no turning was necessary (see Figure 2).

This same year Hugo Sack of Dusseldorf, Germany, applied for patents on a universal mill for rolling beams. In Sack's mill, the flanges were to be rolled flared out in one universal stand and straightened in a separate universal finishing stand. Drawing 37, Figure 1, illustrates the original Sack mill as built in 1910. In the original design the beams had to be turned 180 degrees after each pass to avoid bad overfills on the flanges. Figure 2 of the drawing illustrates the mill plan after it was changed by the addition of another universal stand. The addition of this extra stand made it unnecessary to turn the beams over. The roll stands of the revised mill are shown in Figure 3. The roll train included two



Drawing 38 — Early universal beam mill designed by J. Kennedy and H. Aiken in 1889 had driven vertical rolls.

stands of two-high reversing roll stands which were used for rolling various standard sections.

J. Kennedy and H. Aiken of this country took out patents in 1883 for a three-stand universal mill. The roughing stands had horizontal work rolls with backing up rolls and with the backing rolls driven. The vertical

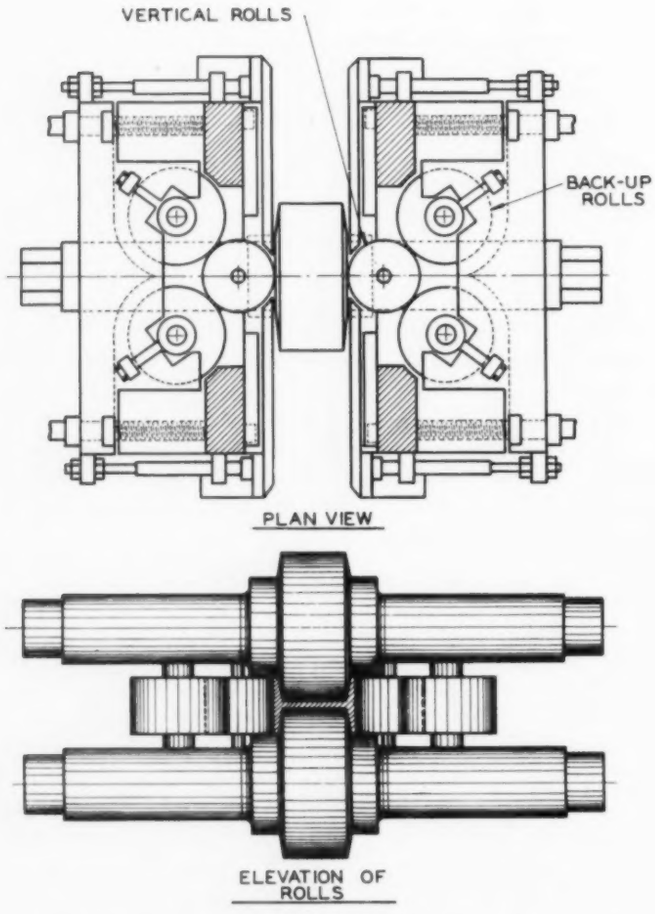


FIGURE - 1
L. S. & J. E. YORK'S UNIVERSAL BEAM MILL PATENT OF 1889

Drawing 39 — York universal beam mills.

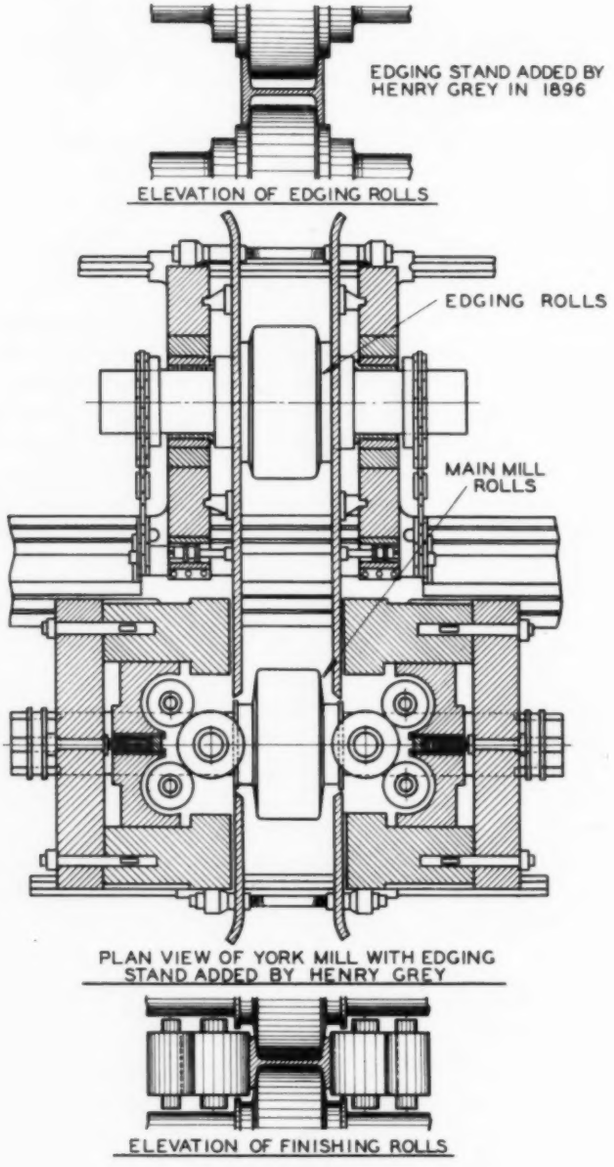
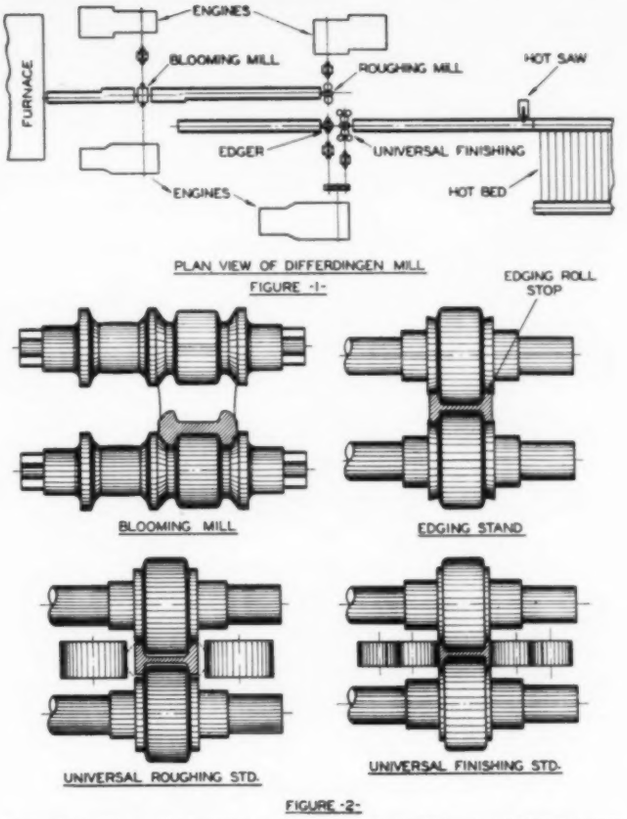

EDGING STAND ADDED BY HENRY GREY IN 1896
ELEVATION OF EDGING ROLLS
EDGING ROLLS
MAIN MILL ROLLS
PLAN VIEW OF YORK MILL WITH EDGING STAND ADDED BY HENRY GREY
ELEVATION OF FINISHING ROLLS

FIGURE - 2
YORK MILL OF 1892 WITH ADDED EDGING STD.



Drawing 40 — Universal beam mill built at Differdingen Germany in 1902.

rolls were also driven. The intermediate vertical rolls were not driven. The two-high finishing stand regulated the flange length and finished the beam. Drawing 38 shows this patent.

In 1889 a patent for a universal mill was granted L. York and James York. In this design each vertical work roll is backed up by two rolls for greater strength and rigidity. See Figure 1, Drawing 39.

The Ironton Structural Steel Co. of Duluth, Minn., built a York mill in 1892. Experiments were made for four years without much success. In 1896 Henry Grey came from the Cleveland Rolling Mill Co. to take charge of the mill. He built a two-high flange edging stand behind the York mill and in 1897 began rolling beams. See Figure 2, Drawing 39. The mill was not too satisfactory and rolling was discontinued.

A German mill operator visited this works and on his return to Germany built a mill in Differdingen based on Grey's plans, and in 1902 this mill began producing commercially profitable beams. Drawing 40 shows the plan of the mill and the detail of the mill stands.

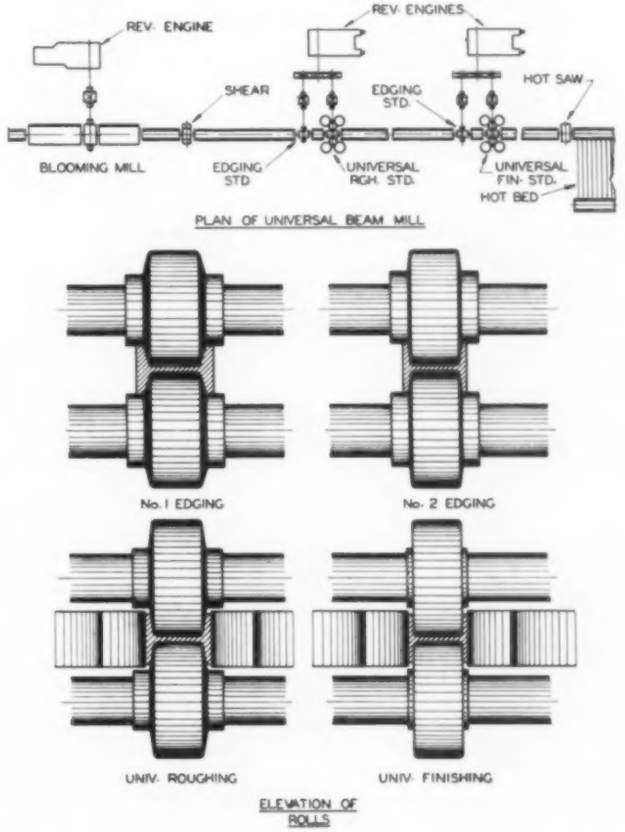
The mill at first consisted of two stands arranged much the same as the mill at Duluth; i.e., a four roll universal set and a two roll edging set. Later a separate universal roughing set was installed. In this set most of the heavy reduction from the blank was accomplished. Figure 2 of Drawing 40 shows the rolls of the mill. The blooming rolls produced a bloom with the outside corners chamfered off. With this type bloom it was practical to roll flange and web down in the roughing set and edge the flange at the same time. After the roughing operation the beam was removed to the finishing stands and given the necessary passes through the edger and universal roll set. In the finishing train the flange is edged down in the edging rolls as the bar passes through the edger. On the return through the edger the edging rolls are spread apart and the rolls do not touch the flange edges.

In this country the first successful Grey type mill was built in Bethlehem, Pa. in 1908. Drawing 41 shows this mill as it is today. A second smaller addition to this mill was built at the same place in 1924. Both of these mills have two groups of stands, a roughing group and a finishing group, and a blooming mill ahead to roll the beam blanks.

In 1914 the Puppe mill was built in Peine, Germany. The rolling scheme as used for a 300 mm beam is illustrated in Drawing 42. The mill included a four roll universal roughing stand in which the flanges were flared out and both web and flanges rolled, and a four roll universal secondary stand continuous with the roughing in which the flanges were edged.

In the original Puppe rolling scheme this edging stand bent flared flanges straight in the forward direction through the stand and on the return pass the vertical rolls were backed off and the flanges were edged by the horizontal rolls. The original procedure was changed for beams such as the 300 mm one shown. It was found that the beam could be edged in the earlier passes in the secondary stand without bending the flanges straight. This practice is illustrated in Figures 3 and 4 of Drawing 42 which show the first forward and return pass through the edging rolls. In the last times through the edging stand the procedure was different. Figures 5 and 6 of the drawing illustrate this procedure. In the forward pass the vertical roll straightened the

Drawing 41 — Bethlehem Steel Co.'s universal beam mill.



flanges. On the return pass the vertical rolls were backed off and the horizontal rolls edged the flange but did not touch the web. In the final pass through the edging stand the bar was rolled as shown in Figure 7 of Drawing 42 with full contact on the bar by horizontal and vertical rolls. This was the finishing pass.

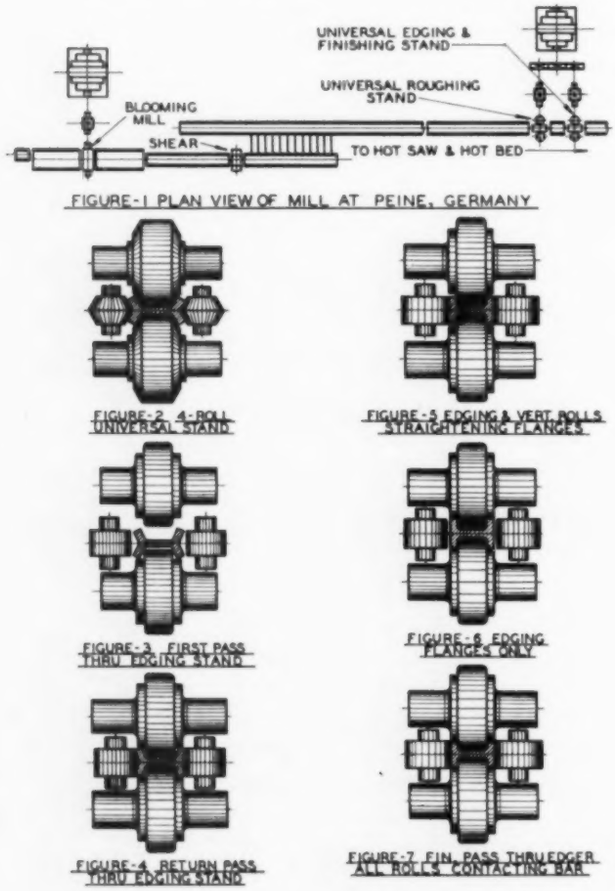
There were no other significant developments in universal beam mills until 1926 when the Carnegie beam mill was developed (see Drawing 43). In this type mill the beams are rolled in universal and edging sets with the flanges in a flared out position and they remain in this position throughout the rolling until the final pass, which is taken through a four roll universal finishing stand where the flange is straightened. By this system of rolling it is possible to produce parallel flanges. On this mill the edging stands operate on the flange edges on each pass through the stand. This is possible as each roll stand is driven by a variable speed motor.

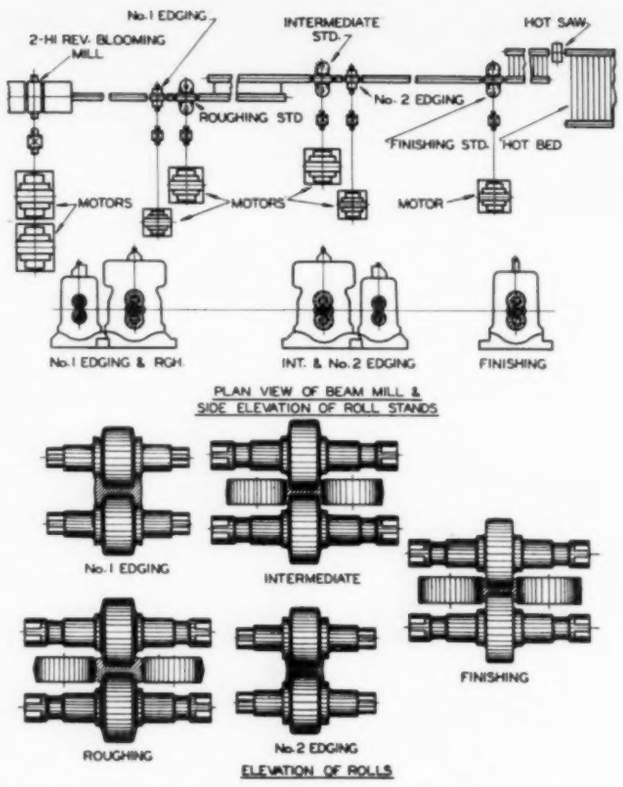
DESIGN FOR UNIVERSAL BEAM MILL

The roll design for universal beam mills is quite different from that of standard structural mills.

In standard structural mill roll design each pass profile is drawn up, and for each pass through the mill in most designs the bar is rolled in a different groove. In the universal beam mill several passes are taken through each stand with the rolls set differently for each pass.

Drawing 42 — Puppe universal beam mill.


UNIVERSAL EDGING & FINISHING STAND
UNIVERSAL ROUGHING STAND
BLOOMING MILL
SHEAR
TO HOT SAW & HOT BED
FIGURE-1 PLAN VIEW OF MILL AT PEINE, GERMANY
FIGURE-2 4-ROLL UNIVERSAL STAND
FIGURE-5 EDGING & VERT. ROLLS STRAIGHTENING FLANGES
FIGURE-3 FIRST PASS THRU EDGING STAND
FIGURE-6 EDGING FLANGES ONLY
FIGURE-4 RETURN PASS THRU EDGING STAND
FIGURE-7 FIN. PASS THRU EDGER ALL ROLLS CONTACTING BAR



Drawing 43 — Carnegie-Illinois Steel Corp. beam mill at South Chicago, Ill.

For the mill shown on the previous drawing, roll design consists of designing the finishing horizontal rolls with the correct width for the section to be rolled and with the proper fillet at the corners of the web. With these two exceptions the horizontal finishing rolls are alike for all beam sizes. The vertical rolls of the finishing stand are the same for every section in the mill.

In the intermediate mill the rolls are designed to furnish in the final pass through the two stands the proper section to enter the finishing mill. In addition to the universal stand, this mill has a two-high edging stand, located after the universal stand and continuous with it, which is designed to work only on the ends of the flanges and regulate the flange width. The rolls do not touch the web. The horizontal rolls of the universal stand must have the right width and corner fillet, but otherwise the rolls are of the same general design for all sections. The vertical rolls are alike for all beam sections of the intermediate stand.

The edging stand rolls which regulate the overall flange width are designed only to edge the flange. As a result, only one beam size can be rolled with a set of edging rolls, while in the universal rolls several beam sizes can be produced, providing the roll is suitable in width and corner radii. In the roughing stands which have the edging stand ahead of the universal stand, the conditions are the same as for the intermediate mill.

All beams are rolled from a beam shape produced on the 54 in. two-high reversing blooming mill preceding the finishing mill. The beam blank must be proportioned to provide suitable draft and elongation for the passes in the finishing mill. For the intermediate and roughing mills a number of roll settings are provided while the finishing, with its one pass, requires only one

setting. In the finishing mill the setting is provided for by hand operated screws regulating the distance between horizontal and vertical rolls.

The varied settings from pass to pass in the intermediate and roughing mills are provided for by motor driven screws which vary the spacing of horizontal and vertical rolls for each pass through the mills according to predetermined pass settings.

The two mills are equipped for hand control operation of the screws while the rolls are being set for the final pass, but during rolling the successive roll settings are regulated on an automatic switchboard which controls the distances that the screws travel to adjust the rolls from pass to pass. Sufficient variation is provided in the plugs on this board so that almost any draft can be had.

The roll design on this mill consists of fixing the right widths on the horizontal rolls and the proper fillet, and on the edging rolls the right widths and the correct length of the stops and the right fillet. The blooming design provides rolls to give the proper size of beam blank and from the blank figuring the flange and web thickness and the edging roll web thickness and flange length for each pass through the mill.

In fixing widths of roll passes on standard structural mills the initial width is set so that the beams will be under the nominal depth. The pass wear of beams rolled on standard mills is such that at each roll dressing the overall beam depth becomes greater.

On universal beam mills the rolls become narrower at each dressing so the initial roll width is for the maximum permissible beam depth, and at each dressing the roll width becomes less until the minimum is reached.

Drawing 44 shows the design for a 24 in. x 160 lb wide flange beam. Figure 1 shows the blooming mill roll design. The center groove is where the 25 in. x 30 in. ingot weighing 12,500 lb is rolled down to a size suitable for No. 2 groove which is used to roll and prepare the ingot to a suitable size for pass No. 3 which is the beam blank groove. In this groove the piece is rolled several times with a decreasing web thickness until the blank overfills at the roll parting. It is then turned 90 degrees and the overfill edged off in the center pass, after which the blank is returned to Pass No. 3 and given a few more passes and finished. After this it is sent down to the shears to be cropped and then the blank goes on to the finishing mill where it is rolled without reheating.

In the roughing stand of the 52 in. finishing mill the beam is rolled forth and back through the two stand mill eleven times. The edging stand which operates on the flange edges is continuous with the universal four roll mill with 12 feet between the two stands. The two stands are reversing and roll the beam forth and back.

After the 11 passes through the roughing mill the beam goes on to the intermediate roll stand where it is given 5 passes. The intermediate stands are also continuous and reversing. The edging stand is placed differently from the roughing group which has the edging rolls next to the 54 in. mill. In the intermediate group the edging is toward the finishing mill. The operation of the intermediate stand on the beam is similar to the roughing. After finishing the 5 intermediate passes the beam goes on to the finishing stand.

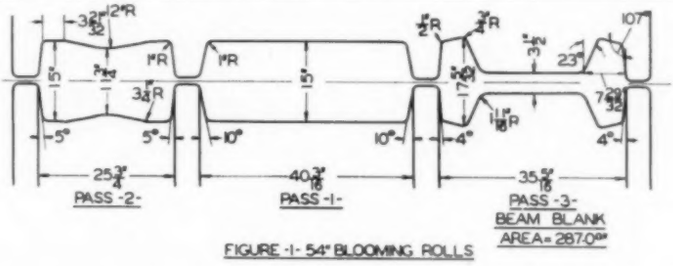
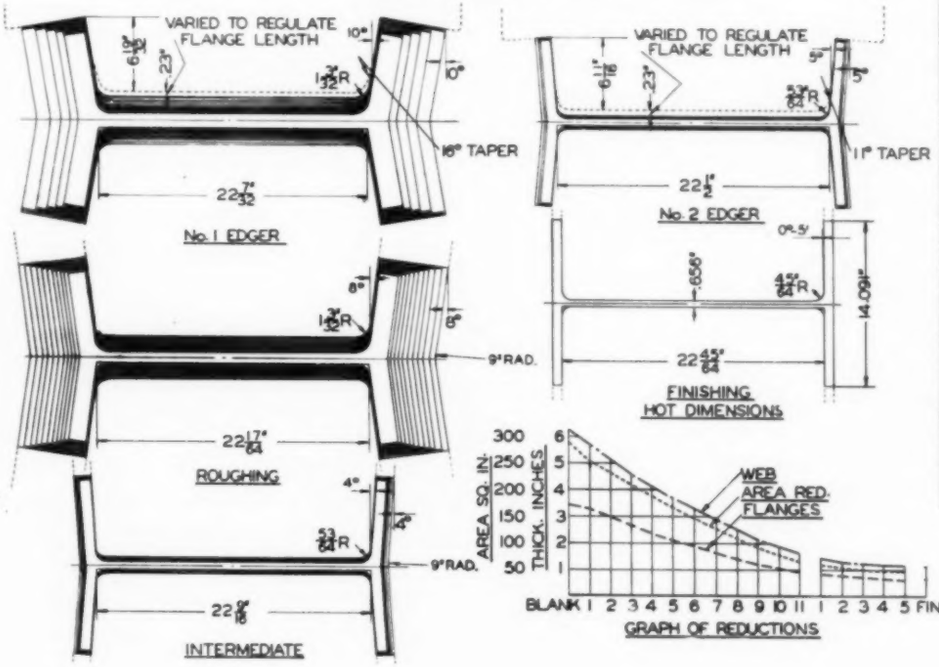


FIGURE -1- 54" BLOOMING ROLLS



NOTE:- EDGING ROLLS DO NOT TOUCH WEB OF BEAM. ONLY WORK IS ON TOP OF THE FLANGES. (SEE EDGING PASSES)

CHART OF REDUCTIONS

PASS No.	STAND	PASS AREAS	WEB THICK.	FLANGE THICK.
1	EDGER	287.0	3.50	6.14
2	RGH.	257.0	3.32	5.71
3	RGH.	233.5	3.00	5.13
4	EDGER	"	"	"
5	EDGER	"	"	"
6	RGH.	208.0	2.68	4.57
7	RGH.	187.5	2.40	4.09
8	EDGER	"	"	"
9	EDGER	"	"	"
10	RGH.	164.2	2.16	3.69
11	RGH.	147.0	1.92	3.29
12	EDGER	"	"	"
13	EDGER	"	"	"
14	RGH.	126.5	1.68	2.89
15	RGH.	108.0	1.44	2.49
16	EDGER	"	"	"
17	EDGER	"	"	"
18	RGH.	93.0	1.24	2.15
19	RGH.	80.5	1.06	1.85
20	EDGER	"	"	"
21	EDGER	"	"	"
22	RGH.	69.3	.92	1.61
23	INT.	58.0	.81	1.41
24	EDGER	"	"	"
25	EDGER	"	"	"
26	INT.	54.3	.74	1.29
27	INT.	52.2	.70	1.22
28	EDGER	"	"	"
29	EDGER	"	"	"
30	INT.	49.5	.68	1.18
31	INT.	48.0	.67	1.16
32	EDGER	"	"	"
33	FIN.	47.04	.656	1.135

Drawing 44 — Method of drafting CB 243 x 160 lb beam section.

The finishing is a four roll universal stand where only one pass is given. The draft is very light on this stand, rarely more than 0.010 in. in the web and 0.015 to 0.017 in. in the flange. The side rolls are straight and bend the flared out flanges of the beam straight.

The reductions of the various passes in the 52 in. mill are shown in graph form, and it will be noted that the graph curves provide a gradually increasing draft for both flange and web and also for pass areas.

The conclusion to be drawn from a study of these charts is that in the universal beam mill it is quite possible to have a progressively increasing draft in both flange and web of the beam and in proportion to the ratio of web to flange thickness while in the standard mill roll designs we have shown in our previous discussion, owing to the necessary construction of the rolls and passes, uniformity of draft from pass to pass and between flange and web is not possible.

The universal mill while ideal for beams is not readily adapted for other shapes. In one or two instances, slabs and billets have been rolled and channels attempted with more or less success, but the mill remains essentially adapted for beams only and the standard type structural mill remains in favor due to the ability to roll all structural shapes as well as a great variety of miscellaneous sections.

A number of beam and channel designs have been shown in the discussion. These are only a few of many. A full exposition of beam and channel roll design would fill a large book. Time and space do not permit going into the subject in greater detail.

GENEVA STEEL CONVERTS PLATE MILL

▲ CONVERSION of the 132-in. semi-continuous plate mill of Geneva Steel Co. near Provo, Utah, now permits production of coiled, hot-rolled breakdowns as well as continued production of high-quality steel plates. The coils form the starting material for the production of tin plate and sheet steel in the new cold-reduction sheet and tin plate mill recently completed in Pittsburg, Calif., by Columbia Steel Co. The hot-rolled coils also will be supplied eventually to Columbia's new sheet mill planned for Los Angeles, Calif.

The plate mill equipment as it existed before conversion consisted of a two-high scale breaker, a four-high spreading stand, a four-high reversing rougher driven by a double-armature 7000-hp motor, a rotary crop shear, a two-high scale breaker, four four-high finishing stands (each driven by a 5000-hp motor through individual gear-reduction sets), runout table, miscellaneous transfer tables, and plate-finishing equipment.

The conversion project consisted primarily of two phases: first, the addition of necessary machinery (including side guides and loopers) in the hot-mill line for production of hot-rolled coils together with handling and storage facilities for these coils; second, the rearrangement of facilities and addition of new equipment (including a new four-high roller leveler) to the plate-finishing department to provide a more efficient means of handling and finishing plates produced from the same mill line. Part of the second phase will not be completed until late in the summer of 1949.

The three continuous, pusher-type, slab-heating furnaces, each of 78 net tons per hour capacity, were retained to supply heated slabs to the converted mill.

A new addition to the mill itself was a slab squeezer that was installed just following the broadside or spreading stand of the original mill. Drive for the squeezer is of the crank type, operated by a 275-hp motor. An existing accumulator provides hydraulic pressure for the squeezer. In addition, a new underdriven, detached-type vertical edger was provided, and is located on the entry side of the four-high reversing mill that serves as a rougher. The vertical rolls are of the overhung type and are 45 in. in diameter.

Two new 132-in. four-high stands were added to the existing four stands of the finishing train (stands No. 5 and 6). The other stands have been so geared that speeds at No. 6 stand are double those formerly obtained at stand No. 4. Characteristics of the several stands are given in Table I.

The mill conversion for hot-rolled coil production was completed by installing two downcoilers, designed to handle material up to 77 in. wide. Coils weighing 460 lb per in. of width, with a maximum outside diameter of about 56 in. can be handled by the downcoiler equipment.

The hot-coil conveyor system was designed to handle coils from 36 to 58 in. in outside diameter, 18 to 77 in. wide, with a maximum weight of 20,000 lb, at temperatures from 1000-1400 F. The hot coils cool on their way to storage.

TABLE I

Speed Cone of the 6-Stand Finishing Train (Based on 30-In. Roll Diameter)

Unit	Motor hp	Motor speed (rpm)	Gear ratio	Roll speed (rpm)	Delivery speed (fpm)
Scale-breaker	500	150/600	22:184	17.9/71.7	120/480
Stand No. 1	5000	125/245	42:178	29.5/57.8	230/460
Stand No. 2	5000	125/245	38:112	42.4/83.1	340/650
Stand No. 3	5000	125/245	45:80	70.3/137.8	550/1080
Stand No. 4	5000	125/245	55:70	98.2/192.5	770/1510
Stand No. 5	5000	125/245	Direct	125/245	980/1020
Stand No. 6	5000	150/294	Direct	150/294	1180/2310

TRENDS IN HIGH SPEED ROLLING

. . . . maximum rated rolling mill speeds have now reached such high limits that developments in the near future will be directed to more effectively utilizing the speeds which are available, thus increasing product tonnage . . . .

By RALPH H. WRIGHT
Metal Working Section
Westinghouse Electric Corp.
East Pittsburgh, Pa.

▲ SPEED usually is defined as a rate of motion with respect to some reference point. There is always the concept of relative motion. Likewise in the mind of an engineer, the term "high speed" implies comparison with some lower speed which itself may at one time have been considered high. This is particularly true of rolling speeds. The top rolling speeds of a few years ago for some products were below the present threading speeds for the same product.

This changing concept of speed is a part of the general pattern into which most developments fall. When a new process or device is first conceived, the engineer's first concern is to make the process or device workable. At this stage, the speed usually is low. If the initial effort is successful, economic pressure and public demand make it necessary to increase the speed. Also, it is human nature not to be satisfied with existing practice. Anyone who tries to duplicate equipment only a year or so old knows about this. Finally the demand for more speed usually reaches the point where it is necessary to stop and determine what the probable maximum limit may be, how to attain it, and whether it is economically worthwhile to make the effort.

The development of the airplane is an excellent example of this procedure. Controlled flight in heavier-than-air machine was shown to be practicable by planes having maximum speeds below 40 miles an hour. By the close of World War I, small fighter planes with maximum speeds of 150 miles per hour were available. The quest for speed continued until now we have transport planes good for cruising speeds of over 300 miles per hour and single seater planes good for maximum short time speeds of 650 miles per hour. The increase from 40 miles per hour to 650 miles per hour was made without too much concern about the rise in temperature caused by air friction and about other phenomena which occur as the plane attains the speed of sound. But now, before any further advances are made, it is necessary to pause for study of ways to overcome these effects. And it probably will be a long time before transportation at such speeds will be available at popular prices.

In the steel industry, the classic example of this natural trend is the cold roll mill. The rise in the delivery speed of tinplate mills from 300 fpm to over 5000 fpm has been continuous. With each increase in speed, the problems of the mill designer and mill operator have multiplied. The chief mechanical problems have been the lubrication of the strip, the cooling of the rolls and the production and handling of the larger coils which are required to utilize the maximum operating speed to the best advantage. The increase in the weight of the coils has had as much effect as any other factor in making higher delivery speeds economical. A few years ago with the 12,000-lb coils then being used, there seemed to be a decided limit to the rolling speed which could be used to advantage. Now with coils of 20,000 to 30,000 lb, the economical limit has been raised materially. The transportation of such heavy coils has in turn become quite a problem. So, many engineers think it is now time to stop and review the entire cold mill situation.

In most industrial processes, any temporary or permanent halt in the rise in speed usually is not due to lack of suitable electrical equipment. For example, in the manufacture of paper, the present limit of speed is determined entirely by the nature of the material. As far as the electrical equipment is concerned, it would be possible to operate a paper machine much faster than the present limits of 1500 to 2000 fpm. The speed is limited by the rate at which a satisfactory strip of paper can be formed in the wet end of the mill, and this is fixed by the rate at which the excess water can be removed.

In the rolling of steel, the maximum speed is in general limited by rate at which the metal will flow under pressure from the rolls, by the rate at which metal can be threaded through the mill, and by the rate at which the finished product can be handled after it leaves the mill. Assuming that pickup of metal on the rolls and other mechanical difficulties could be eliminated, some hot rolled products such as rod or hoop might be rolled at higher than present speeds, if the mill were threaded at slow speed just as is done in a cold strip mill. However, in order to do this without excessive off-gage material, it would be necessary to weld one billet to another at the furnace and to provide a flying shear to cut the finished product to suitable lengths for handling. The difficulty and expense of providing for such a procedure would not be justified, particularly with material which can be rolled in multiple strands.

Presented before AISE Philadelphia District Section Meeting, January 3, 1948

Hot rolled products which are finished at relatively high speeds are:

Rod	4000 fpm
Hoop	3000 fpm
Merchant bar	2500 fpm
Strip	2000 fpm

Rod is a product which can be rolled in multiple strands so there has been no urgent reason for attempting to increase the speed above the present limits. Rather, the tendency has been to increase the flexibility of the mill so as to reduce the quantity of carefully matched rolls required for regular operation. This has been done by splitting the roll train into a number of sections, each section driven by a separate adjustable speed motor.

The use of a number of motors in a tandem train introduces the problem of dealing with the transient speed changes caused by sudden changes in load. The transient speed changes are due to the inherent characteristics of the electric motor. Any direct current motor has a natural tendency to run slower or faster when loaded than at no load. By refinements in design or by means of external regulating equipment, such a motor can be made to have the same speed at full load as at no load. But regardless of this, there will be a momentary drop in speed if load is applied suddenly.

The inability of a motor to assume load instantly without change in speed is due to a combination of conditions. First, current will not flow into the armature until the internal generated voltage has been reduced. This requires a reduction in speed which may be permanent or temporary depending on the final speed regulation of the motor. Then, the inductance of the motor windings slows down the rate at which the current can rise. This usually causes the speed to fall more than is necessary to establish the required value of current. The current finally will overswing and some or all of the speed drop will be recovered.

During the time required for the current to rise, the flywheel effect of the rotating parts must carry part of the load. Since stored energy can be released only by a drop in speed, the inertia of the rotating system has considerable effect on the shape of the transient speed curve. By increasing the flywheel effect, the rate of speed change and the amount of speed change are reduced. Likewise, a decrease in the inductance of the motor windings will also be beneficial. However, there is a practical limit to the amount of reduction in inductance.

When the adjacent stands of individually driven groups are on close centers, the effect of the transient speed changes is first to stretch the bar and then to form a loop. If a second bar is entered in the mill, the bar which is already in the mill will be affected more than the second bar. For many years this problem has stood out as a challenge to rolling mill engineers and electrical engineers.

The successful solution of this problem for a tandem rod finishing train in Baltimore gives promise that permanent relief is at hand. This mill train receives rod, single strand, from a looping mill and delivers it to the reels at 3000 fpm. There are five stands, three horizontal and two vertical, mounted on 6 ft 0 in. centers. Each horizontal stand is driven by a 200-hp, 250-volt, d-c motor and each vertical stand has a 200-hp twin-motor drive consisting of two 100-hp vertical motors.

The new features of the electrical equipment are that each motor has extra flywheel effect and has an electronic speed regulator. In order to obtain the maximum response, the regulators control the motors through boosters in the armature circuits. The extra flywheel effect reduces the rate of change of speed and the flywheel effect and the regulators limit the total amount of transient speed variation. The flywheel effect has been selected so as to match the electrical characteristics of each motor. For any combination of inductance and field response characteristics, there is a value of flywheel effect which will give the best transient speed conditions. By a newly developed method of analysis involving the use of a special mechanical analyzer, the correct flywheel effect for any set of electrical conditions can be determined. This method of analysis was used for this installation.

The objection might be made to the addition of appreciable flywheel effect that it slows down the rate at which speed adjustments can be made. On the other hand, in a stable system sudden adjustments in speed are not necessary. This apparent contradiction in thinking is somewhat typical of the past and present situations in the electrical field in general. In the old days, many operating men seemed to be chiefly interested in the accessibility of the parts and the speed with which any piece of electrical equipment could be repaired. It was expected to break down sooner or later so the idea was to make repairs as quickly and easily as possible. Now, with more reliable equipment and more experience in its proper application, details of construction are less important. By proper design and application, overall performance is improved.

The fact that narrow strip or hoop can be rolled in two-high mills, down to quite thin gages at a speed of 3000 fpm would indicate that hot strip could be rolled at somewhat higher speeds than are now in use. One limit would be the expenditure which could be justified for the main drives. The use of twin-motor drives for the finishing stands would provide a way to apply as much power as could be used and would eliminate the necessity for careful matching of rolls, so the drives themselves would not fix the limit of speed. A more serious engineering limitation would be the difficulty of providing suitable coilers and a suitable flying shear.

The difficulties of designing a flying shear increase about as the square of the speed. For a flying shear for a new 68 in. hot strip mill in Baltimore having a maximum speed of 2000 fpm, it has been necessary to make rather drastic revisions in the design of the electrical equipment. Instead of being driven by one or more geared mill type motors, this shear has a single direct connected motor rated at 900 hp, 300 rpm. Power is supplied from a 750-kw, 600-volt, variable voltage generator. The shear is synchronized with the mill by electronic control and adjustments for mill speed and cut length are made entirely by electrical means.

Due to the tremendous demand for cold rolled steel, aluminum, brass, and copper, many types of new cold mills have been purchased and installed. To secure the required results, it has been necessary to abandon many old practices. So many new ideas are being tried that

just now it is difficult to predict what rolling practice may be in a few years. Some of the outstanding installations in the steel industry include a four-stand sheet mill designed for 3000 fpm, two five-stand tin mills designed for 4000 to 5000 fpm and some temper pass mills designed for around 3000 fpm.

One thing stands out in all these installations—the consistently high tonnages which can be rolled without resorting to the use of the maximum available speeds. The four-stand sheet mill, operating at speeds between 2000 and 3000 fpm, has rolled 50,000 tons of product in one month, a considerable part of which was tinplate. One of the five-stand tinplate mills, seldom operated at more than 4200 fpm has an indicated capacity of 45,000 tons of tinplate per month. These tonnages are about twice the output being obtained from the best mills one year ago. The increased outputs are due to a combination of improved preparation of the hot rolled strip, heavier mills, improved rolling practice and higher speeds; possibly in about the order named. The probable tendency for the next few years will be to develop the maximum possibilities of the present higher speeds before considering further increases in speed. Recent experience does indicate that it is possible to increase temper pass mill speeds materially where there is any advantage to be gained by so doing.

Among the new things which are now being tried out for strip rolling, the following are particularly noteworthy:

X-ray thickness gages for hot and cold strip.

Independent compensation for coil diameter on tension reels.

Individual generators for tandem mill drives.

Twin-motor drives.

At high speeds or with the slightly rough surface required for some grades of cold rolled sheet stock, the service on a mechanical thickness gage is very severe and maintenance may be very high. For such conditions, the ideal gage is one which does not touch the metal. The X-ray gage operates in this manner and gives a very accurate indication of any departure from the desired thickness by comparing the radiation through the strip with the radiation through a standard of known thickness. The accuracy is not affected by the temperature of the strip, so the X-ray gage can be used for hot strip as well as for cold strip. Since the indication is obtained while the strip is being rolled, corrections in screwdown settings can be made while the mill is operating. This makes it unnecessary to wait until the coil is finished as is now necessary in hot rolling, and thus gives the equivalent of a higher mill speed. A number of X-ray gages are in successful operation on cold mills, and it is understood that preliminary trials indicate that they will be satisfactory on hot mills. X-ray gages will probably make it possible to have automatic control of strip thickness at some time in the future.

The first electric tension reel drive for a cold mill consisted of an adjustable speed motor, a generator driven from the mill stand and a constant current regulator. The regulator maintained tension and simultaneously compensated for coil build-up by controlling the motor field current. When the mill was stopped, the reel motor was connected to the 230-volt d-c system through a resistor, thus maintaining some tension at standstill. With some improvements, this regulating scheme is still satisfactory for small mills operating at low speed and with small coil build-up. However, for high speed and large coil buildup, such a simple scheme is not adequate. For such conditions, it becomes necessary to use separate regulators for regulating the current and compensating for coil diameter. In a single stand reduction mill with tension on both sides of the mill, the requirements are complicated by the fact that changes in draft affect the speed and tension on the entry side of the mill.

Photo-electric scanners have been used as a means of compensating for coil diameter in single stand reduction mills. In this system, a light source and a photoelectric tube are positioned automatically so that the light beam is always in line with the periphery of the coil. Movement of the light source and photocell actuates a rheostat which provides the correct field strength in the reel drive for the coil diameter at any instant. A separate regulator, operating in the field of the reel generator or booster, maintains constant current in the armature circuit. This combination maintains constant tension on both sides of the mill at any speed and draft. A number of installations have been made for aluminum and brass mills. The scheme has possibilities for single stand mills for steel.

For the latest tandem cold mills, the tension control and coil diameter compensation also are handled as separate functions. The successful operation of this system has made it certain that it will be used in some form for reels for future tandem mills.

Some of the latest tandem cold mills have a common main bus. Others have a separate generator for each motor. If the maximum mill speed is over 1500 fpm, it is desirable to have series boosters to compensate for motor resistance drop when the common bus system is used. This system requires a minimum of auxiliary exciters and in general gives the most simple electrical equipment. However, when the mill motors are of high capacity, the IR drop boosters become so large in current capacity that their use is undesirable. The IR drop

Skilled operators are required to obtain the maximum production out of a modern tandem mill, such as the one shown, which will deliver strip at speeds up to 5000 fpm.

boosters can be eliminated by providing a separate main generator for each mill motor, since resistance drop compensation or its equivalent can be included in the generator control. The rupturing capacity of the circuit breakers can be reduced. On the other hand, it is necessary to provide regulating exciters for matching the speed of the mill motors. So in general the use of individual generators gives a simpler bus system and more complex control wiring. Since either arrangement can be made to operate with entire satisfaction, the choice in future high speed installations will be determined by the user's preference and by the mill design.

A number of installations of twin-motor drive are in operation both on reduction mills and on skin pass mills. Probably none of the new ideas which have been tried out in cold mills has aroused so much comment. Practically all engineers and operators are agreed that twin-motor drive has definite advantages for a mill which runs dry such as a skin pass mill. For reduction mills which run with lubrication on the strip, opinions are divided, although none of the actual users have found any positive evidence that twin-drives do not perform as expected.

Twin-motor drive for cold reduction mills was never proposed as an end in itself but rather as a convenient means of providing high capacity at high speeds. The electrical problems are the same whether each roll has its own motor or whether a multiple armature motor with armatures in parallel drives both roll through a conventional pinion stand. Experience with one mill in which the motors of the twin drives can be locked together mechanically has shown that roll slippage and other occasional mechanical effects occur under the same conditions, either with the motors locked together or operating independently.

The effect of unequal load division seems to be the chief question in the minds of most engineers. Unequal load division at full speed does not seem to affect the operation of a mill with twin drives. Unequal load division at threading speed could conceivably cause the strip to run up or down as it leaves the rolls. Since it is relatively easy to obtain accurate load division under all conditions, this feature will not be a deciding factor in determining the type of drive for future cold reduction mills. The overall cost, the user's previous experience and practice in grinding and stocking rolls, and the user's preference as to mechanical arrangement of the drive will be the chief factors.

During a war period such as we have just been through, the emphasis is on gross steel production and little consideration is given to the development of new rolling mill equipment and processes. This time, due to the advance planning of the steel industry, notable advances have been made in a relatively short time after hostilities ceased.

Much of the success of recent installations is due to the willingness and ability of the steel plant operators to accept new and untried equipment, regardless of how complicated it may have seemed at first sight. Regardless of the size of the plant, men have been found who could understand, operate, and maintain the equipment. This is in marked contrast with the attitude of twenty-five years ago when desirable operating features were often sacrificed in order to simplify the electrical equipment.

High rolling speeds are desirable only when they are responsible for increased tonnages at the end of the month. There is nothing to indicate that higher speeds are not physically possible, particularly for cold rolling. However, because of the excellent tonnage records of the most recent installations, the tendency just now is to emphasize overall balance of design rather than higher speed for future mills. That is, high speed is given a goodly share but not all of the credit for the impressive tonnage records which have been established. Thus, by following the policy of being always ready to try a new idea which looks promising and at the same time developing the maximum possibilities of each forward step, progress in the industry is continuous and permanent.

DISCUSSION

PRESENTED BY

F. O. SCHNURE, Supt. Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

W. H. BURR, Supt. Electrical Dept., Lukens Steel Co., Coatesville, Pa.

GILES SYDNOR, Supt. Sheet Tin and Steel Divisions, Bethlehem Steel Co., Sparrows Point, Md.

H. W. POOLE, Mgr. Steel Mill Division, General Electric Co., Schenectady, N. Y.

H. V. THOMAS, Master Mechanic, Bethlehem Steel Co., Sparrows Point, Md.

L. F. COFFIN, Supt. Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

R. H. WRIGHT, Metal Working Section, Westinghouse Electric Corp., East Pittsburgh, Pa.

F. O. Schnure: Mr. Wright has given a very good resume of the engineering problems that come up in the design of tandem cold mills and other high speed rolling mills so that it can easily be seen that a lot of good judgment must be exercised one way or another. It is possible to power a mill designed for a narrow schedule for almost any reasonable speed, but for a mill that is to roll a combination of tinplate and sheet tonnages, the first question that arises is whether to power it for the heaviest sheet rolling schedule which might require double the horsepower of the lighter or tinplate schedule or strike a happy medium. The degree of future happiness will depend on how the operators respect the power limitations on the mill since no protective relaying can be provided.

Since the ultimate in high speed rolling has not been reached, it would seem the best policy to provide reserve power so that the mill will be able to utilize any reasonable increase in speed as improvement in rolling practice would dictate. However, it appears to me that the problems to be faced in the future on high speed mills are those of stopping without wrecking them or the electrical equipment. This deals with the problem

of inertia. Mill rolls and spindles, when broken by high speed wrecks can be readily changed, but when the shock follows through to the motor couplings, shafts and armatures the problem is more serious.

W. H. Burr: As we have listened to Mr. Wright tonight, I doubt if we fully realize how much this high speed really means in the production of steel and how much it contributed to the success of our nation during the war. At the present time, as you know when purchasing new equipment about all you hear is: "We cannot get steel." Therefore, anything we are able to do to increase the speed of operation will make it possible to get out more tonnage which is so vitally needed at this time.

The author mentioned that we had purchased equipment on certain occasions because it could be repaired quickly. This statement would at least raise a question as to why this was done. Possibly some of the equipment had to be fixed so often that the mills would have been down even more than they would have been had this not been done.

The other thing which came to me as I listened this evening, and the one which impressed me more than any other was how much the steel industry is indebted to the electrical industry for the progress which is being made and has been made in the operating performance in the steel mills.

Giles Sydnor: I was pleased that you mentioned the problems pertaining to lubrication, the heating of the strip, the heating of the gage and the micrometer itself, and the inaccuracies of the results, as we now do it, and for the hope you held out. We are looking forward to getting non-contact gages. We appreciate that up until now, in general, the operating people depend upon electric people to design this equipment. I want to point out to you that the operating people usually use the full speed that you put in the equipment at one time or another and will try to overload any equipment you ever design.

H. W. Poole: As always, Mr. Wright has done an excellent job and has presented a very fine discussion of the problems and trends in high speed rolling, not only with regard to rod mills but also in connection with the new high speed tandem cold strip mills. I would like to give enthusiastic support to one thought which he expressed.

The problems of today are not only electrical, but they are also economic. Considerable study had to be given to the economics involved in connection with the high speed rolling mills which we have today, and considerable more thought must be given to the consideration of even higher speed mills in the future. In addition, there are very real mechanical and metallurgical problems to be solved. In general, however, it is safe to say that the electrical industry is ready to supply the necessary equipment for even higher speed mills whenever they can be justified.

One of the new high speed tandem cold strip mills has a top rated speed of 6000 fpm. I do not mean to say they have rolled steel at 6000 fpm, and I think it will be quite a while before they do. Since these comments were given, this mill has rolled steel at 6250 fpm. Electrically, they can do it any day. From the standpoint of the coolant, roll shape, handling, etc., there are some real problems with which to contend. This particular mill, as Mr. Wright has pointed out, has twin drives on the work rolls of Stands 3, 4, and 5 and, in addition, has several other novel features. An X-ray gage is being installed for non-contact measurement of strip thickness. Adjustable voltage control is used on the screwdowns and this is quite unusual, if not unique, for cold rolling mills. The operators are very happy with this adjustable voltage control for the screwdowns and would not want to go back to the more conventional rheostatic control.

Mr. Wright mentioned the possibility of putting X-ray gages on existing strip mills. I am glad to say that there is an X-ray gage in operation on one continuous hot strip mill. Difficulties have been encountered as we fully expected, since the application of electronic equipment to a hot strip mill presents some difficult problems. However, these difficulties are being rapidly overcome and it is interesting to note that these problems have not been in connection with the fundamental principles of the X-ray circuits but rather with the little common place things such as cable, oil pump motors, etc.

It is always risky to make any further predictions, but at the risk of being proved wrong by future developments, I would like to make a prediction regarding high speed tandem cold strip rolling. It is my belief that it will be quite some time before new mills are installed with higher nominal speeds than those which we have today, but rather I think emphasis will be placed on some of the other problems. I believe that in the not too far distant future, we will see definite efforts being made to eliminate the threading of individual coils as is now done on our tandem cold strip mills. Some means will be found to allow the mill to run continuously without slowing down to threading speed. In order to do this, better welding equipment and techniques will have to be devised, and automatic means of threading alternate reels will have to be developed. Nevertheless, I believe that these things can and will be overcome so that the off-gage strip which is now present at the ends of the coils can be reduced, and the threading time can be eliminated.

H. V. Thomas: I certainly enjoyed Mr. Wright's paper tonight. Since I am connected with sheet, tin and strip divisions, we have a number of high speed mills, and there are a number of problems connected with high speed mills.

Mr. Wright mentioned that there is a possibility of driving a hot strip mill train with individual motors, that is with two motors; one to drive the top roll and the other motor to drive the bottom roll. With this arrangement the mill pinions will be eliminated and odd size work rolls can be used.

I was wondering if with the steel going through the mill-train at high speed, just how the individual motors can be synchronized on load and speed after a roll change without cobbling. I figure that this is quite a problem, but I am sure that it can be worked out and I believe it would have an advantage over the present drive.

L. F. Coffin: Mr. Wright's reference to automatic screwdown control and to the X-ray gage for measuring thickness of hot strip on either or both edges of the

strip while being rolled, leads to conjecture in the minds of some who might look into the future, as to the possibility of relating the two, so that the thickness may automatically be controlled by this X-ray gage. The ideal of a mill that will always hold proper automatic tensiometer control and screwdown control and gage on all stands, may be too complicated ever to be realized, but at least, the thought is interesting.

R. H. Wright: I wish to thank Mr. Sydnor and Mr. Burr for their kind remarks and particularly for their comments regarding cooperation between users and manufacturers of mill equipment. Each learns from the other and usually the manufacturer has the most to learn.

The problem of mechanical and electrical balance in the design of tandem of cold mills, as mentioned by Mr. Schnure, is very important. It is relatively easy to determine the power and speed requirements for any given set of rolling conditions. The problem is to decide what range of conditions can be provided for economically in any given installation. At the present stage of the development of the art of cold rolling, it usually is desirable to provide some margin of power and speed for possible future conditions. This may very easily introduce mechanical problems.

Mr. Coffin's suggestion of automatic control of gage in a hot strip mill probably represents the present idea of the ultimate in mill refinement. It is quite possible to design an X-ray thickness gage to operate auxiliary contacts when the error in thickness exceeds a certain amount. Finding a way to make corrections in response to such signals is not entirely simple. This is a subject which should and no doubt will receive the attention of a great many people in the future.

The use of some form of multiple armature drives for higher hot strip mill speeds was mentioned because a material increase in horsepower and roll speed over present practice would exceed the limits of good design for direct connected single armature motors. Motors for greater capacity at higher speeds than are now in use would, therefore, have two armatures. The two armatures could be coupled together to form a double armature motor or they could operate independently as a twin-motor drive. Since load balance equipment would be required for either arrangement, the electrical systems would be quite similar for either type of drive. If the mechanical design could be worked out satisfactorily, the twin-motor drive would have some advantages.

Mr. Thomas has quite logically mentioned the only special feature which might be required for a twin-motor drive for a hot strip mill stand—a means for matching the speeds at no load. The roll surface speeds at no load would have to be approximately the same in order to avoid excessive shocks when the strip enters the rolls. Means for adjustment would be especially necessary if there was any appreciable difference in the diameter of the work rolls. After the strip enters the rolls, the regular equipment for load division would, of course, equalize the loads and speeds. Relatively simple means for manual adjustment of motor speeds would seem to be satisfactory for the no load condition.

All those concerned with the design and operation of tandem cold mills will heartily agree with Mr. Poole's comment on the importance of increasing the average rolling speed by eliminating time lost in threading and slowing down for welds. In the relatively short period between the date of this meeting and the publication of the proceedings, improved welding techniques have been found very beneficial in increasing the output of the new high speed mill which he has described. An improved welder with electronic timer has made it possible to run a high percentage of welds through the mill at full speed without breakage.

WANTED!

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Contour Roll Turning

. . . . a new roll lathe of interest to the roll turner uses a thin sheet metal template and follower to guide the cutting tool . . . .

By S. A. BRANDENBURG
Vice President
The Monarch Machine Tool Co.
Sidney, Ohio

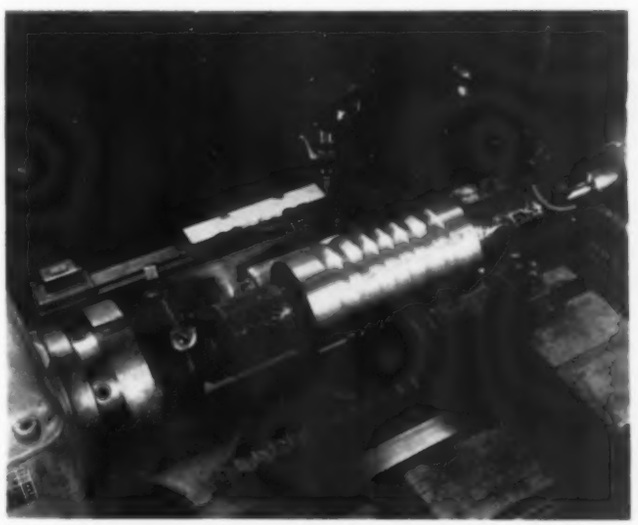
▲ CONTOUR roll turning is not new. Rolls of various types and in various industries have been satisfactorily machined in this way for seventeen years. Rolls have been turned to produce metal formed sections in the cold roll forming process. Rolls have been turned for various types of straightening machines, and a few small mill rolls were turned in England just ten years ago. Steel mill rolls, however, up until a year ago, had never been turned satisfactorily on this continent by the contour method, principally because carbide tools had not been developed which would stand a high enough surface cutting speed, on the extremely hard materials that must necessarily be used for mill rolls, to give an overall machining time which would prove economical in comparison with the long established form tool method employed by the conventional roll lathe. Even today there are some types of metals and some shapes on mill rolls which can be machined more economicaly on the conventional roll lathe than they can by contour methods.

Less than a year ago, one of our standard lathes was purchased by an aggressive user for the express purpose of turning formed mill rolls. The direct savings using the contour method were enormous and, with other hidden savings possible, conclusively showed that an electrically controlled lathe should be designed specifically for roll turning. This has been done, and by the end of 1949 nearly twenty of these machines will be installed all over the United States and in some foreign countries. All of the orders placed have been on the basis of a saving estimated from the actual performance of this original installation. Probably nearly a hundred steel men interested in roll turning have seen this installation, and if they have the type of rolls to produce which are the types that will show enormous savings, they have either placed their orders for this type of turning equipment or they are seriously considering it. The savings, which can be taken from an actual record of performance, indicate that the installation of this type of roll turning equipment is one of the best investments a steel company can make. It indicates that they will get a higher return on their invested capital than on probably any other machine tool.

The contour principle is not new. It was originally introduced to the machine tool buying public in 1931. Since then, there are well over a thousand machines all over the world giving a continuously good account of themselves as applied to accurate contour turning. The principle as applied to a lathe is basically one where a thin sheet metal template through the medium of a follower guides the cutting tool, accurately duplicating the template. In Figure 1 a thin sheet metal template can be seen on which is the contour required on the outside diameter of the roll. The length of the template is also the length of the body of the roll from neck face to neck face. The tracer which touches the template has three positions, determined by a few ounces change of pressure against the template. One position creates feed toward the center line of the machine. The next position creates feed parallel to the center line of the machine, and the third position creates feed away from the center line of the machine. This means that the tracer can tell the tool slide to go in any one of three directions of feeding travel that are required to produce any shape on the outside diameter of a roll.

The tracer and the carbide turning tool are mounted on the same slide and are moved longitudinally by the same carriage so that the relation between the template and the finished work piece are consistently in a one-to-one ratio. In other words, 0.001 of an inch on the template will be reproduced exactly 0.001 of an inch on the work piece. The tracer point can be any diameter. It can be a very small diameter, even down to $\frac{1}{32}$ in., or it can be several inches in diameter, but it must at all times be in direct proportion to the diameter of the carbide turning tool. The carbide turning tool is invariably a few thousandths of an inch smaller than the diameter of the tracer. This difference, however, is

Figure 1 — The template shown in the back of the photograph controls the operation of the lathe and guides the tool so that the correct shape is formed on the roll.



Presented before AISE Buffalo District Section Meeting, January 11, 1949

nothing more than a calibration for each machine, and it will remain constant for all types of contours and all diameters of tools required. If the form on a roll needs to have a one-inch diameter tool, then the tracer for that tool will be one inch and 0.004 or 0.005 of an inch in diameter.

In operation, the longitudinal feed to the carriage is by means of the leadscrew. The cross travel to the tool slide is by means of the crossfeed screw. Here is where our controlled principle differs from nearly every other type of contour control, and here too is the secret of the success of this principle as applied to roll turning. Since all tool motions are screw operated, the tool is moved positively into tracer-controlled position and the enormous tool pressures will have no effect upon the accuracy of the contour being machined, as would be the case if the tool was to be controlled by hydraulic or similar mediums. The cross and longitudinal screws are actuated in their rotary motion by means of magnetic clutches. The magnetic clutches from one direction to the other can be energized or de-energized by means of the tracer in $\frac{1}{125}$ of a second, which means that just as soon as the contour on the template requires tool motion, the tool has been moved. So much for the control principle.

Now let us see how a steel mill roll is turned on this new machine. First of all, on rolls up to 24 in. in diameter, it has been found satisfactory to position the rolls on centers on this machine, contrary to the usual need for neck supports on a roll lathe, because the tool pressures are not nearly as great. In some mills an additional saving is found here because with the standardized center and counter bore, the centers retain their accuracy with reference to some portions of the roll. In some cases it has been found that the necks can be machined to renew concentricity between the neck and form without recutting the form on the roll. In roll shops where the standardized center has not been adopted, centers of other than 70 degree angles can be used in this machine because both the headstock and tailstock centers are removable. On rolls up to 24 in. in diameter, it is largely necessary to rotate the roll on centers because of the higher speeds used with this contour controlled method, and because the tool is going to be accurately controlled from a template, and the alignment of the template holder is always perfect with reference to the center line of the machine. If we were to position the roll on the necks for machining, it would be very difficult to retain alignment without elaboroate set-up.

An additional saving from template control comes from the fact that we can machine rolls without reference to pairs. The length of the body of the roll and the timing of the form with reference to the necks will always be the same as the template. Therefore, we can machine two or three or a dozen top rolls with the same form, if required, and then immediately kick over and run an equal number of bottom rolls, and when they are applied in the mill their alignment will be perfect, or one of a pair of rolls can be removed from redressing without needing the other for matching.

With this roll turning lathe the operator has a finger tip control of the cutting tool. He can take the body diameter from rough cast size and, in one continuous cut with a carbide tool, top off the outside diameter. Then as he takes the form turning cut, if the tool gets into more depth of cut than it can stand because of the contour, by the flip of a switch he can stop its "in" motion so that the tool will be turning oversize for that part of the contour, and this will continue until the tracer again touches some portion of the template, at which time the electrical control will follow the template. His next cut to get down to size can be started by flipping a switch so that from the time he starts to machine a contour roll until the end of the finish cut, the operator can manipulate the positioning of the tool by means of switches. This makes it possible for him to always keep the tool cutting metal, but at all times the template at the rear of the machine is going to act as an automatic stop so that it is impossible to turn a contour undersize.

During the roughing operation, it is generally customary to use a tracer that might be as much as $\frac{1}{8}$ in. larger than the tool. This will automatically leave $\frac{1}{16}$ in. on all contour surfaces for finishing. Then by moving the tracer up to the finish turning diameter, he is in a position to take one continuous final finish cut throughout the entire contour. During this finish cut and during many of the roughing cuts, the operator has nothing to do but watch the tool do the work. It can be seen from this description that much less skill is required to produce accurate contours on rolls by this method. This again, in many cases, will be an additional hidden saving.

On this new roll turning lathe, a spindle speed range of from $2\frac{1}{2}$ to 505 rpm is provided. Eight of the twenty-four speeds in the lower range are created through a face plate drive. This is done so that if a contour cannot be economically created by the template controlled method, a form tool, high speed or carbide, may be used for this portion of the roll. This wide range of speeds gives the flexibility required to use the exact surface cutting speed on all diameters of rolls up to 24 in. which will be required to get the maximum satisfactory tool life. The machine can be provided with automatic constant surface cutting speed control if the contour of the rolls has enough variation in diameter to justify the additional investment. The machine, however, can be provided through a direct current motor drive, with a manually controlled speed change arrangement at the operator's position, so that he can vary the speed depending upon the cutting action of the tool, the diam-

Figure 2 — Standard carbide turning tools are used with speeds as high as 110 surface fpm.

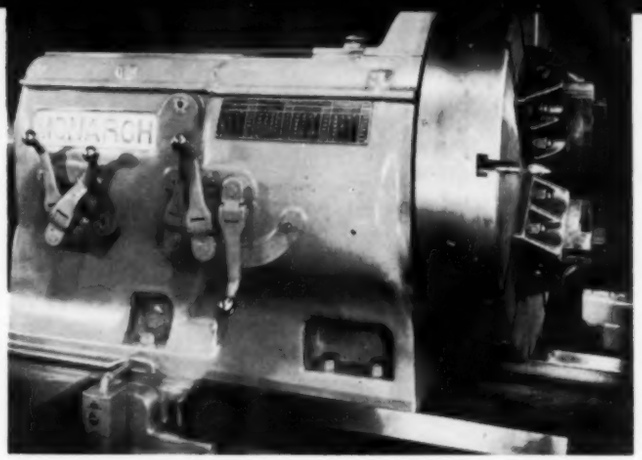


Figure 3 — Headstock of the new 32-in. roll turning lathe has two drives, in one there are sixteen fast speeds for carbide turning with single point tool ranging from 10-505 rpm, and in the other there are eight slower face plate drive speeds for form tooling ranging from 2½ to 15 rpm.

eter being machined, or the change from one diameter to another as the contour progresses.

An additional time saving feature on the roll turning lathe is a push button rapid traverse. The operator, by just pressing a button, can cause the carriage to rapid traverse from any one position along the bed to any other position, and it is so arranged that at no time does he disengage his electric contour control. In other words, he can rapid traverse his tool from one end of the roll to the other end of the roll and immediately start another cut.

For contour turning a round carbide tool is used. Generally the insert type proves most satisfactory, using a perfectly cylindrical carbide tip mounted vertically. This round tool can be used to produce literally thousands of different shapes in the roll. As long as the radius on the tool is smaller than the radius or radii required on the roll, the same tool can be used. It is never necessary to have tools ground especially for certain contours, because the template through the electrical control is going to cause the round tool to accurately reproduce the shape required. Therefore, a great reduction in the number of tools required results. Where thousands of tools are stored away now, probably six or eight turning tools will cover nearly all of the shapes that might be required in any one roll shop. It is true that a template is required for each roll shape, but here again is a large saving because every time that shape is required, or every time the roll needs to be recut, that template gives you the assurance that the contour on the roll will be exactly like the contour which was originally placed on the roll. There is no chance of the operator modifying the shape.

The template also provides an easy place to keep an accurate record of the speeds and feeds that proved satisfactory, because on the template itself can be stamped or etched the speed used, the feeds used, and the tools which proved most satisfactory. Other items, such as the customer's name and the date of the original rolling, can be put on if it proves of value. In some cases it has been of value to put, at one point on the template, the diameter of the roll, because after that diameter is secured, all other diameters and contours will be duplicates. This, of course, would only be true in the manufacture of new rolls, and would not apply in roll shops where redressing operations constitute the larger portion of their work.

Another saving that comes from the template controlled method of roll turning is in redressing rolls. The operator can quickly position his tool where he thinks the greatest amount of wear has occurred, and by energizing the feeds until the tracer touches the template, he can be positive of proper tool setting with reference to the template, and can take off the proper amount of metal to be sure to clean up the entire roll at one continuous pass. He will never have to go back and take another cut.

We have been talking about rolls up to 24 in. in diameter, and many will be interested in applying a similar principle to rolls larger than 24 in. In this connection we have an electrically controlled unit which can be placed on present modern roll lathes in place of the piano rest, with little or no modification. This electrically controlled contour unit will work satisfactorily on contour rolls turning up to 59 in. diameter. The principal change required in modern roll lathe design is to eliminate some of the compounds in the headstock drive to provide higher spindle speeds.

DISCUSSION

PRESENTED BY

HARRY W. EVANS, Roll Designer, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

S. A. BRANDENBURG, Vice President, The Monarch Machine Tool Co., Sidney, Ohio

H. Evans: How about wear on roll necks?

S. A. Brandenburg: We start out with a pair of rolls, the necks of which have been turned on centers. So we turn the body of the roll on centers and all working portions of the roll are concentric. In the mill the rolls are run on the necks. Consequently, there is the possibility of some wear on the necks or body which could result in eccentricity. When redressing rolls, this eccentricity can be corrected by taking a slight cut across the necks at the same time that the roll is being dressed in the lathe.

The general structure of the roll turning lathe does not make it possible to do the machining on smaller rolls when supported on the necks because with carbide tools, the rolls will turn over sometimes as high as 200 rpm or more. The neck supports could not be maintained without getting extremely hot or without changing position as they must be adjusted tightly for accuracy. Therefore, the most satisfactory mounting is to use the centers which were originally placed in the roll prior to machining the necks. On larger rolls over 26 in. in diameter, it might be possible to turn the contours with a carbide tool supported on the roll necks because the surface speed on the necks might be low enough that heating would not result.

H. Evans: Are the centers drilled in the roll or do they consist of tool steel center plugs screwed in the ends?

S. A. Brandenburg: All the rolls we have seen have had center holes machined in the castings. A 70 degree center seems to be the general adopted standard for rolls. We have not run into any rolls that were furnished with plug inserts.

Symposium on Handling Heavy Coils

. . . . in modifying mills to handle heavier coils, one question which must often be decided is whether the coils should be handled by crane, truck or conveyor . . . .

Cranes

By R. G. BIRKIN
Cleveland Crane and Engineering Co.
Cleveland, Ohio

▲ UNDER present day conditions of both high demand for steel and high manufacturing costs, productive efficiency is certainly foremost in the minds of all of us. A great deal of thought is obviously being given to this problem at the present time, and if any means can be found that can be expected to increase productive efficiency they are certainly being investigated very carefully.

One of the methods that is being used in strip mills today, in order to increase productive efficiency, is the use of much heavier coils. At the present time some strip mill facilities have already been modified to the extent necessary to handle coils up to 30,000 lb, and a great deal of planning and redesigning is being done with 60,000 lb coils in mind. In some cases it is understood that even heavier coils than this are being contemplated.

The use of heavier coils in conjunction with the modern high speed mills has brought about not only a substantial increase in production rate, but has also increased the overall yield. In turn, however, the heavier coil has brought with it many problems in coiling, annealing and handling.

Insofar as overhead traveling cranes are concerned, the use of heavier coils in strip mills really presented no problem. It is not necessary for the crane industry to develop new crane designs, because mill cranes of ample capacity to handle coils of any size have been built, and are in every day use in various departments of all of the steel plants. So the heavier coil really does not present any problem to the crane manufacturer.

At the present time, in general, the heaviest coils are approximately 30,000 lb. Also, the lightest capacity cranes found in most modern strip mills are of 15-ton capacity. From this it would appear that where cranes are to be used for the handling of coils the existing equipment appears to be of ample capacity.

The problem, however, changes somewhat when coils of greater weight than 30,000 lb are to be handled. Under these conditions there are certain limiting factors, such as the restricted aisle space which may exist in any mill layout, and the maximum load carrying capacity of the mill floor, which may indicate that cranes will prove to be the most practical method for coil handling. In this case, unless existing crane equipment in the coil handling area is of sufficient capacity some provision for extra crane capacity must be made.

Our company has been involved recently in modifying some of the cranes built by us for a large strip mill, because this particular mill will be eventually handling coils up to 50,000 lb. The cranes that were affected by this change in coil weight were originally rated at 15-ton capacity, and were of 120 ft span.

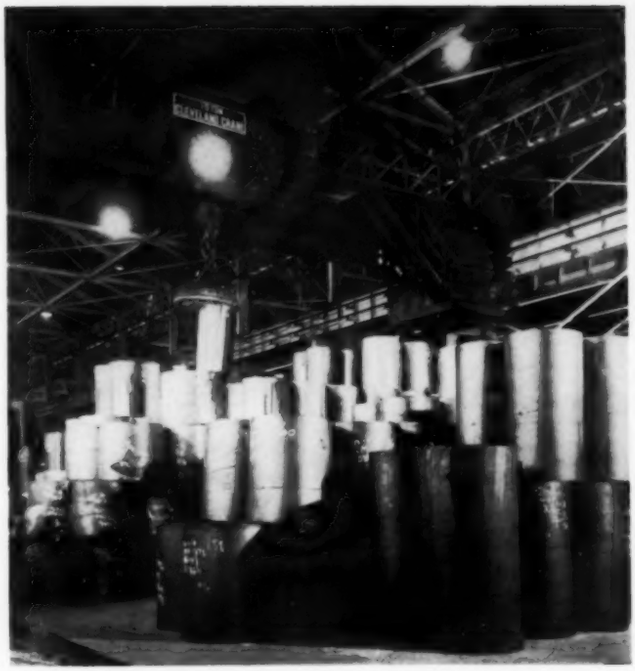
One of the cranes, in addition to handling 50,000 lb, was also going to be required to handle an occasional 70,000 lb load. In this case the simplest solution was the installation on the existing 15-ton crane of a new 35-ton capacity trolley and hoist unit.

Two other 15-ton cranes were involved, which were also of 120-ft span. The problem here was to increase the crane capacity to approximately 27 tons for handling of the 50,000-lb coils. The solution in this case was the modification of the existing hoist unit. The hoist was originally equipped with six parts of $\frac{3}{4}$-in. rope. The hoist unit was modified for an eight part $\frac{3}{4}$-in. rope reeving. In this case the load on the hoist machinery and the electrical equipment remained approximately the same. Due to the change in the rope reeving, there was, of course, a reduction in hoisting speed. This did not prove to be a disadvantage, because of the fact that much larger coils were being handled, and the frequency of the handling was correspondingly reduced.

The increases in bridge girder stresses which occurred due to the imposition of the heavier loads are of interest. Originally the cranes with their rated live load of 15 tons had stresses in compression of approximately 9,000 psi. The stresses in tension were approximately 11,000 psi. It is interesting to note that of the 11,000 psi tension stress, approximately 9,000 psi is due to dead load, the live load accounting for only 2,000 psi.

In the case of the crane where a new 35-ton trolley was installed on the existing 15-ton bridge, the dead load stress increased, due to the heavier trolley weight, from 9,000 to 9,400 psi, and the live load stress increased from 2,000 to approximately 4,600 psi, making a total stress in tension of 14,000 psi. The corresponding increase in stress in compression was from 9,000 to 11,600 psi. These higher stresses were considered satisfactory, inasmuch as they are well below those specified by the AISE Crane Specifications and also in view

Presented before AISE Annual Convention, Cleveland, Ohio, September 30, 1948



Standard coil handling cranes, as the one shown, can often be easily modified to handle larger loads.

of the infrequent 35-ton load. They would also, of course, be correspondingly reduced during the handling of a 25-ton coil. Expressed in percentages, the percentage of stress due to live load under the original 15-ton crane rating was 19. The percentage of stress due to the 35-ton live load increased to 33.

In the case of the two cranes where the increased capacity was obtained by additional parts of rope, the stress in compression when handling a 25-ton load is approximately 10,300 psi, compared with the previous 9,000 psi. The stress in tension increased from 11,000 to approximately 12,600 psi. The dead load stress in tension in this case, of course, remains the same, namely, 9,000 psi. The live load stress increases from 2,000 psi when a 15-ton load is handled, to 3,500 psi when a 25-ton load is handled. In this latter case, when a 25-ton load is handled, only 28 per cent of the total stress is due to the hook load.

The changes that were required to increase the rope reeving from six to eight parts were relatively simple. It was necessary to remove the hoist drum and rescore it for the additional amount of rope which was involved in the eight part reeving. The trolley tie piece was reinforced to take the additional load, and a new top block sheave assembly, providing an additional sheave was necessary, and of course, a new eight part 25-ton bottom block was required. The cost of making this change was approximately 10 per cent of the original cost of the crane.

Most strip mills are pretty generally equipped with overhead cranes which have been designed to the Association of Iron and Steel Engineers' specifications for steel mill cranes, or specifications which are even more conservative. Since most strip mill cranes are of long span, the handling of heavier loads does not increase the girder stresses beyond a safe point, because the total stress has been increased only a small amount, since most of the stress in the long span crane girder is dead load stress.

A secondary trend, which is definitely tied up to the use of heavier coils, is the use of larger slabs. In this it will usually be found necessary to purchase heavier cranes for the slab yard.

Trucks

By B. I. ULINSKI

The Electric Industrial Truck Association

New York, New York

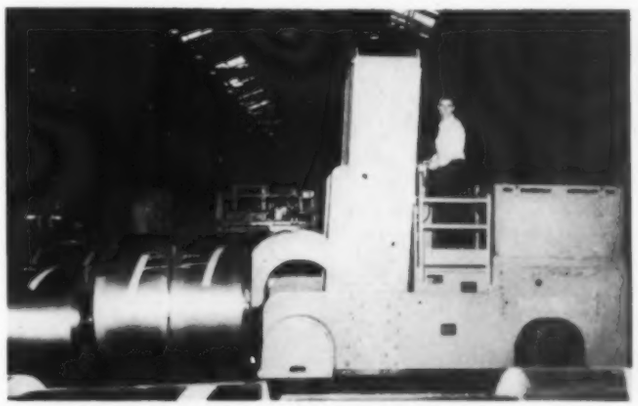
▲ THE electric industrial truck industry has anticipated the present and future coil handling needs in steel mills and discusses here the latest available developments in heavy duty industrial truck equipment that has been especially designed for handling the huge steel strip coils produced in today's and tomorrow's rolling mills.

The process of strip steel rolling is outlined first, so that those who are not acquainted with the progressive processing of steel will understand the limitations of various methods of handling the huge strip coils.

Today, as in past years, the most important factor affecting the weight of finished unwelded coil, is the capacity of the open hearth furnace, which (depending on size) produces cast ingots weighing from 2900 lb to 18,000 lb. These ingots are formed into rough slabs which are then delivered to slab yards by railroad cars.

Mill handling operations start at the slab yards. The slabs are nearly always handled in the yards by overhead cranes equipped with magnets. These large magnets unload the railroad cars, place the slabs in storage position in the yards and eventually feed them to the magazine loaders on the soaking furnaces. After being heated in the reheating furnaces to the desired rolling temperatures, the slabs are discharged by gravity onto a powered roller table which moves them through scale breakers and other processing operations to the roughing mills. Progressive squeezing action of the huge rolls in the rolling mills gradually reduces the thick slabs to some predetermined thickness. As the thickness is gradually reduced through progressive rolling action, the

Figure 1 — The storage battery powered ram truck, which is shown with two coils of hot rolled strip, has a capacity of 30,000 lb. In tin plate department shown, material is handled exclusively by battery powered trucks.



original slab becomes an extremely long sheet of steel which is moved along a powered roller conveyor and eventually wound into a loose hot roll. At this point the hot rolled coil probably weighs 25 per cent less than the original ingot because of trimming and cropping losses during processing.

No outside physical handling means are required except in emergencies, from the time the rough slab enters the soaking furnace until it emerges as a hot-rolled coil. The hot-rolled coils, which are really hot at this stage, are then moved to storage. From storage they are moved through the pickler, which chemically cleans the scale and other impurities from the surface. From the pickler the coil is moved to the cold reduction mills where it is further reduced in thickness by cold squeezing in huge mill rolls. The cold reduced coil is then moved to the cleaning lines, and then to the annealing furnace where surface hard spots and internal strains are relieved. From annealing furnace it is moved to temporary storage for cooling purposes, and then to temper mills, which gives the steel strip a final finished appearance by rolling action. These final finished coils are then moved to departments where they may be processed into tin plate, punched or cut to size according to orders, or shipped intact as coils.

It is interesting to note that from the time the hot mill produces the hot-rolled coil until it leaves the temper mills, the coil is uncoiled and rewound at least four times—through pickler—cold reduction mills—cleaning lines and temper mill. At each of these processing points the enormous machines have to be slowed down or stopped entirely to thread each coil. Considerable production time is lost by such delays.

About 20 years ago when strip mills operated at a speed of 200 fpm using small 7500 or 8000-lb coils, the lost rethreading time was not too objectionable. Later when the speed was stepped up to 1500 fpm, the amount of strip rolled in a day increased almost proportionately. When the rolling speed was stepped up to 3500 fpm, it was found that production did not increase proportionately. Too much time was lost in rethreading the mills. The mill barely got up to speed before it had to slow down again for the end of the coil. In addition long pieces at both ends of the coil were "off-gage" and had to be trimmed off as scrap. Today's mills, with potential speeds of 5000 fpm or better, have the same problem and it is much more serious in terms of potential lost capacity. The length and weight of the strip coil must be increased to some 50,000 lb or more in order to reap the manufacturing economies that the new high speed rolling mills are capable of delivering.

Steel slabs today generally weigh around 12,000 to 14,000 lb before processing. This means that somewhere in the manufacturing of the coil it is necessary to weld at least four one-slab coils together to attain the desired economic coil weight of 50,000 lb or more. The welding of single slab coils into continuous strip is not a serious problem because the steel industry is already equipped to weld single-slab strips together into continuous strip coils weighing 25,000 lb and more. Some other changes naturally will have to be made, for instance the coiling mechanisms will need larger clearances for the larger diameter coils that result from multiple strips.

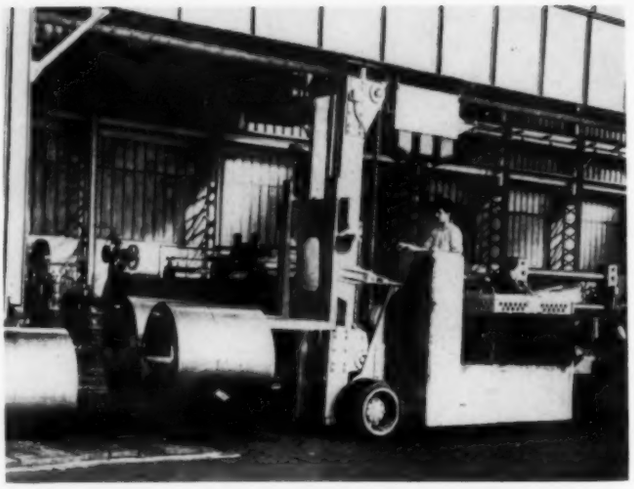


Figure 2 — Another method of handling two coils is here illustrated.

This briefly outlines the factors leading up to the necessity for the 30,000-lb coils that are fairly common today and to tomorrow's giant 60,000-lb coils.

HANDLING OPERATIONS

At several points in the manufacturing process coils must be handled between various processing stages. Slabs are successfully handled almost universally by overhead cranes equipped with magnets.

At the end of the hot mill the coils are wound by an automatic coiler equipped with a collapsible mandrel. When the winding of a coil is complete it is released onto a gravity roller conveyor. At the end of the roller conveyor there is usually a power operated up-ending device that turns the coils on end. At this point these coils are single slab coils and weigh somewhat less than the original slab. Also they are still very hot. Usually an overhead crane with magnet or coil tongs picks up these coils and transfers them to temporary storage where they are usually tiered "on-end." Fork truck handling is often used at this stage. This method requires spacer blocks to permit insertion of the forks. The fork truck method has the advantage of infinite maneuverability. It permits placing the coils outside the area to which the overhead crane is limited. The setting of spacer blocks can be eliminated in the fork truck method by application of truck mounted magnet or coil tongs. This permits handling the coils in exactly the same manner as the overhead crane. However, the fork truck method with spacer blocks is doubtless safest because danger of dropping coils is eliminated when they are handled by forks. For handling coils at this stage, a medium duty fork truck of 15,000 lb capacity and balanced to handle 48-in. diameter coil should be large enough.

From the storage area to pickling line the same method of coil handling can be maintained either by overhead crane or fork truck. Up-enders can be eliminated at these points, by the use of truck methods, thus simplifying the handling of coils. They can be picked up readily by inserting into the coil center a horizontal shaft one end of which is fastened to the fork truck car-

riage. This "shaft" which may be round, tapered, cast, or fabricated to size is normally known as a "ram," and industrial trucks equipped with such a ram are known as "ram trucks." Since the width of the coil is normally greater than the diameter, when handling coils lengthwise the ram trucks should be counterbalanced for the longer length.

Counter-balancing a fork or ram truck is a mystery to many although the principle is as simple as a child's see-saw. Equal weights at equal distances from the pivot exactly balance. If one weight were twice as heavy as the other it would have to be placed half as far from the pivot to make a balance. Expressed mathematically: $Wt_1 \times Distance_1 = Wt_2 \times D_2 =$ inch-pound moments.

Fork trucks are balanced similarly, the pivot being the centerline of the wheels nearest the load. Truck weight on one side of the wheels balances the rated payload on the opposite side, usually allowing 10 to 15 per cent extra moment on the truck side to avoid an actual balance on the wheels.

Confusion arises from the fact that the actual load ratings are not the same as these fundamental ratings because the moment arm (D) is measured from the fork face which is several inches in front of the wheels in order to give a rating in which prospective truck users are interested. This rating is the weight and length of load that the truck will carry on the forks or ram.

As an example, assume that a truck is rated to handle a uniformly distributed 10,000-lb load 48 in. long. The center of gravity of this load is at its center, 24 in. from the fork face. This figure, multiplied by 10,000 lb gives the actual rated capacity of the truck, i.e. 240,000 in.-lb, although the moment arm (D) is shorter than the distance to the pivoting point. Assuming the wheel-to-fork distance is 16 in. the total moment arm would be 40 in., which would give a rating of 400,000 in.-lb. This means that the truck has to be counterbalanced to handle a 400,000 in.-lb moment. Unless this distinction is made by purchasers, actual load capacity may be less than desired.

Up to the pickling line single slab weight coils were handled. The beginning of the pickler line is a logical point to weld several coils together so that further coil processing can be speeded up. It may be assumed then that the coils leaving the end of the pickler line weigh 30,000 lb, or maybe 60,000 lb. Fork and ram trucks with in.-lb moments great enough to handle such coils up to 96 in. wide are available today.

From the pickler the coils can be transferred by ram trucks to storage or direct to the cold reduction mills.

If the run in one direction is exceptionally long, say considerably more than 500 ft, some thought should be given to transporting several coils at the same time by tractor-trailer combination, transfer car or some other acceptable method. In this way the fork or ram truck can do the most direct production handling, for which it was designed, rather than serve as a carrier.

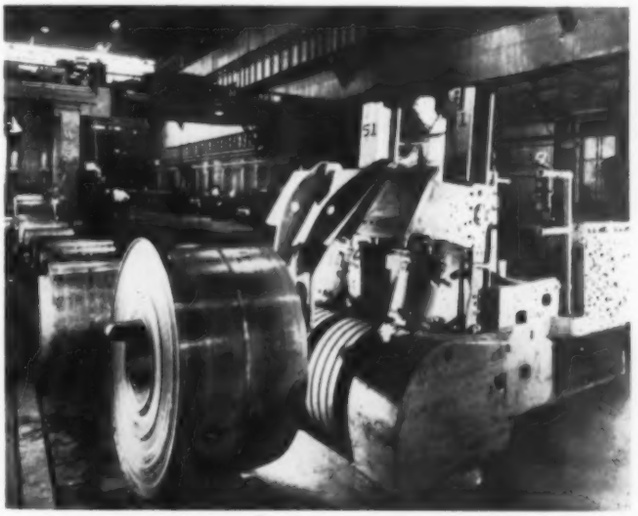
At the end of the cold reduction mills the coils are picked up by a ram truck and put into temporary storage or taken to the coil up-enders. From this point, fork trucks pick up the huge coils and place them on transfer cars, riding on rails, where a heavy duty tractor pushes them to the annealing furnaces. In the annealing furnace area an overhead crane equipped with magnets transfers the coils into the annealing furnaces. After sufficient heating time elapses the coils are picked out of the furnaces by the overhead crane and placed back on the transfer car for movement into the area near the temper mills. Fork trucks again unload the transfer car and place the coils on up-enders. Ram trucks take them to the temper mills from whence the coils come out as shiny beautifully finished rolls of strip steel, today weighing close to 30,000 lb and tomorrow probably 60,000 lb.

TRUCK DEVELOPMENT

The electric truck industry has kept pace, and as a matter of fact today is ahead of the handling requirements of modern rolling mills. The development of the heavy duty truck started several years ago when the mills started modernizing. Up to about 1934, the slow rolling speed of the mill did not require large coils. Lost rethreading time was not as important as later after rolling speed was increased. About 1935 the steel industry realized its need for larger capacity trucks and solicited the electric truck industry, which responded immediately by designing and delivering truck units with capacities of 16,000 lb. Incidentally, keeping in mind the balance previously referred to, all the heavy members of the truck, such as batteries, lift unit and steering axle were positioned as far as possible back from the wheel pivot point, to gain the greatest in.-lb moment possible with the least possible weight.

These trucks helped the modernization program of the mills so successfully that in 1938 it was thought that production could be stepped up beneficially if coil weight could be further increased to 25,000 or 30,000 lb. Again the electric truck industry responded, building truck units capable of handling 30,000 lb overhanging loads up to 90 in. long. These first heavy capacity units were built in 1939 and were rear wheel driven and steered, that is, the wheels farthest away from the load were powered. Considerably more than 10 to 15 per

Figure 3 — Truck capacity is increased by lifting coils so that they are as close as possible to the front wheels.



cent surplus in.-lb weight was required to maintain the necessary traction on the powered wheels. Oily floors also added to the difficulties of obtaining proper traction. Plans were made to design front drive trucks, but had to be shelved for the duration of the war.

Since the war new mills have been built and old ones modernized so that today, rolling speeds of up to 70 miles per hour are attained. At that rate a strip of steel five miles long, will run through the mill in less than 5 minutes. Coils must be larger to prevent excessive slowing up and stoppage of the mill for rethreading. The electric truck industry anticipated this eventual 60,000-lb coil requirement and in redesigning the 1939 rear drive 30,000-lb capacity units to front drive, took into the consideration the giant 60,000-lb rolls that mills will some day be rolling. Simultaneously, trucks with capacities between 20,000 and 60,000 lb were developed, so that many of the parts used in the various capacity units are alike.

All the experience gained in years of mill transportation and truck manufacturing is built into these newest truck units. New solid rubber, large diameter drive tires were developed to reduce the rolling resistance of these giants. By previous experience it was found that wide faced tires, 8 in. or over, actually carried a load better and lasted longer by having one or more continuous grooves about 3.4 in. wide by 1 in. deep cut all around the tire tread. The explanation for this is that tire deformation, which occurs under loaded conditions, has a chance to flow in smaller units sideways with the grooves in the tread instead of forcing all displaced rubber to one side under tremendous internal resistance and outside grinding action. In addition tire makers contributed by developing rubber compounds that have very little internal resistance and wear well on the oily floors encountered in steel mills. Neoprene compound tires are also available wherever unusual oily operating conditions exist.

In this type service, the steering axle, commonly known as the trailing axle, is mounted on the rear of the giant ram and fork trucks, and is power steered either through a gear reduction mechanism or hydraulic ram, obtaining power in either case from a d-c series wound electric motor. Forks or ram are lifted either directly by a hydraulic ram pushing up on the carriage supporting ram or forks, or through a spur gear reduction unit driving a chain lift arrangement. In every design power is obtained from a direct current series wound motor. All three truck movements, driving, lifting and steering are thus power operated, reducing operating effort of these big giants to finger pressure. The high efficiency of these large trucks makes their power requirements surprisingly small.

One 20,000-lb capacity truck for example counterweighed to handle 76-in. long loads weighs approximately 30,000 lb complete with 72-volt battery. After several hours of running, the following current draw readings and operating performance with partially discharged battery were obtained with a truck running on level concrete floor carrying no payload. The two traction motors drew 96 amp at 67 volts, and the truck speed was 4.6 mphr. The distributed weight on the driving wheels was 13,000 lb and on the trailing wheels 17,000 lb. Loaded with a 20,000-lb coil the two traction motors took 114 amp at 67 volts, and the truck travel speed was 3.8 mphr. The distributed weight with a 20,000-lb load on the drive wheels was 47,000 lb and on the trailing wheels 3,000 lb. With no load on ram, lift current was 70 amp at 67 volts. The lift speed was 11 fpm. With a 20,000-lb load on the ram the motor current draw was 121 amp at 67 volts and lift speed was 8 fpm.

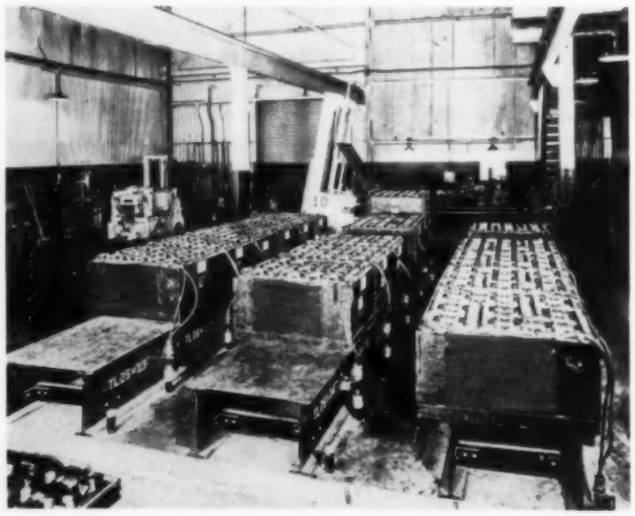
Steering current is drawn in short cycles of 30 to 80 amps. The current input to the steering motor is limited through a line resistor to 100 amp at which point the motor stalls. This is done to avoid pulling rubber off the wheels through carelessness or horseplay.

A 30,000-lb capacity truck counter-weighed to handle 72-in. loads weighs approximately 42,000 lb complete with 72-volt battery. Under operating conditions similar to the 20,000-lb truck without load, the current draw for the two traction motors was 98 amp at 68 volts. The speed of the empty truck was 4.2 mphr. With a 30,000-lb load on the ram the current draw was 118 amp at 68 volts, and the travel speed was 3.7 mphr. The lifting motor current was 70 amp at 68 volts with no load at 8.3 fpm lift, and 125 amp at 68 volts with a 30,000-lb load at 6.2 fpm lift. Steering current was the same as on the smaller truck. The distributed wheel weight with no load on ram was 18,000 lb on drive wheels, 24,000 lb on trailing wheels. With a full capacity load of 30,000 lb the weight distribution was 68,500 lb on drive wheels, 3500 lb on trailing wheels. A total load of 72,000 lb moved at 3.7 mphr with only 128 amp draw across two traction motors.

In terms of power consumption these figures show less than 60 watt-hours per ton-mile. These figures are actual average examples. Equally low power consumption can be expected with 60,000-lb capacity units.

All motors on these giants are controlled by electromagnetic switches, commonly known as contactors, which are actuated by master controllers. The contactors controlling the traction motors are sequence timed by a timing relay and in addition a plugging relay prevents reversing of motors without first stopping them and then gradually speeding up in reverse direction through the time sequence control.

Figure 4 — Proper charging of batteries is an important function in truck maintenance.



Electric power capacity for these trucks including the 60,000 lb capacity units is readily available. Battery makers have worked closely with truck manufacturers during development so that when the large truck units become available, the batteries to power these units efficiently would also be available. Batteries of 800-amphr capacity or more and between 60 and 72 volts have proved satisfactory for 20,000-lb capacity truck units, and 1000 amphr or more and between 60 and 72 volts are proving satisfactory for 30,000 lb capacity truck units. These heavy trucks are usually run more than 12 hours before recharging. Battery manufacturers have developed battery cells for the heavy duty trucks with ratings up to 1500 amphr. One of these 72-volt, 1500-amphr batteries weighs 14,000 lb.

Charging equipment for recharging these giant batteries is also readily available from several sources.

FLOOR SUPPORT

A very important consideration in truck operation is whether the mill floors will stand up under the concentrated wheel weight of these large trucks. Actual experience with 30,000-lb capacity trucks has shown no serious floor problems. These trucks are running satisfactorily on reinforced concrete floors only 8 in. thick with 4-in. wood block tops. Mills usually have reinforced concrete floors 9 in. thick, or more, laid on a sand fill. Sand is excellent fill material but must be retained inside wall structures to maintain uniform floor support. A load of 68,500 lb concentrated on the drive wheels of one 30,000-lb capacity truck is carried by four 16-in. face tires of 36 in. dia. Under this weight the floor contact area of the flattened tire measures approximately 9 in. by 64 in., and makes at least 576 sq in. of rubber in direct contact with the floor. Each square inch of rubber supports an average of about 120 lb.

Ordinary concrete has a crushing strength of 2000 lb or more per square inch, so that it is obvious that the weight imposed on it by the rubber tire will certainly not crush it. If the fill underneath the concrete does not pull away, it can be assumed that concrete floors in steel mills should give excellent service under the 30,000-lb capacity truck wheel loading.

It is my understanding that mill floors are designed structurally to support a distributed coil storage weight rather than for the trucks that operate on the floors. It is not unusual to find floor loading up to 7500 lb per sq ft in coil storage areas. Experience has shown that a 30,000-lb capacity truck requires floors with a minimum rating of 500 lb per sq ft, and a 60,000-lb capacity truck requires a floor rating of 550 lb per sq ft. The 60,000-lb capacity truck will have a concentrated load to close to 120,000 lb on the drive wheels when handling full capacity loads. Bearing this in mind a well known architectural firm was consulted to furnish concrete floor design to carry such concentrated loads. Their hypothetical floor design shows a floor slab 14 in. thick with ¾ in. reinforcing bars 8 in. center to center in both directions on the bottom layer of reinforcing, and ¾ in. bars with 12 in. center to center in both directions on the top layer of reinforcing. The design assumes an overall wheel tread of 96 in., a dynamic load of 50 per cent greater than the static load, and a soil having a bearing capacity of 500 lb per sq ft.

Over swampy ground, the soil capacity is greatly reduced, and will naturally extend the slab carrying the load over a greater area, and consequently greatly increase the bending in the slab.

It is therefore extremely important that sub-soil conditions are thoroughly checked because the soil bearing capacity is the main factor that determines the thickness and design of the floor slab.

Floors on which 30,000 lb capacity trucks are today operating without any difficulties will doubtless support the 60,000-lb units with similarly satisfactory results. This conclusion is based on the fact that mill floors are generally designed for a floor loading of 1600 lb per sq ft, and are actually loaded in storage areas up to 7500 lb per sq ft.

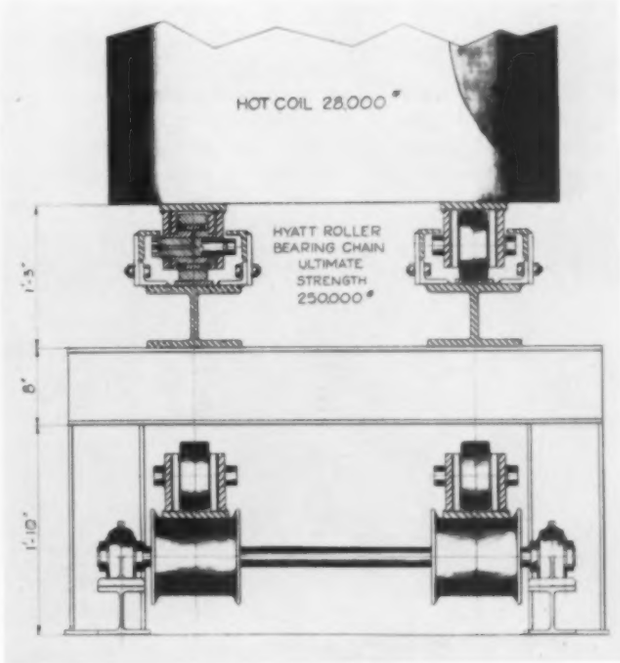
Conveyors

By J. E. McBRIDE
Vice President of Engineering
Palmer-Bee Company
Detroit, Michigan

▲ COILED strip has been conveyed by some kind of mechanical means ever since strip steel has been wound in the form of a coil.

To keep pace, however, with increased speed of the mill, increased size of the coil, increased width of the sheet, and to protect the thin gage of tin plate, further

Figure 1 — Cross-section showing the two strand roller bearing chain coil conveyor.



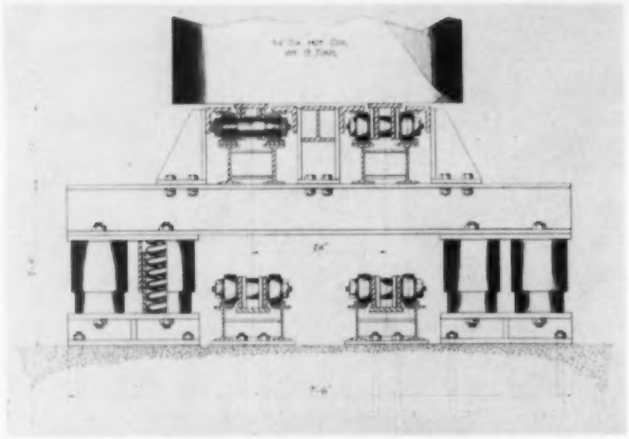


Figure 2 — Cross-section showing two strands of chain with roller bearing outboard rollers and spring mounting.

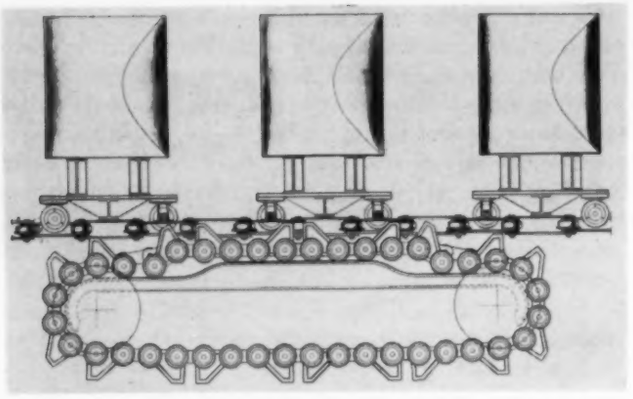


Figure 4 — Side view of carry-all type hot coil conveyor with caterpillar drive shown engaging the conveyor chain for positive location in front of coilers.

progress becomes necessary in conveyor design. Those of us engaged in the manufacture of conveying equipment for the steel mill already have advanced designs installed and in operation, and others are still on the drafting boards.

To take care of these new conditions, the chain conveyor plays an important part; for it is the vital life-line from the hot mill to storage, or to shipping, or to uncoiling for processing. It must provide for the following more recent requirements:

1. Greater unit weight of hot coil now 30,000 lb.
2. Greater distances traveled through the mill. Can be 1,000 ft or more.
3. Change of direction without damage to thin gage strip. Edges of coils for tin plate must be protected from scuffing.
4. Sufficient time for cooling on the conveyor before removal and down-ending, about one hour.
5. Greater volume to be handled, about 1500 tons per hour.
6. Automatic weighing of coil while in transit.

This paper will describe and show how these requirements are accomplished.

The handling of coiled strip readily separates into two divisions, the hot coil and the cold coil, the handling of which will be taken up separately and in that order.

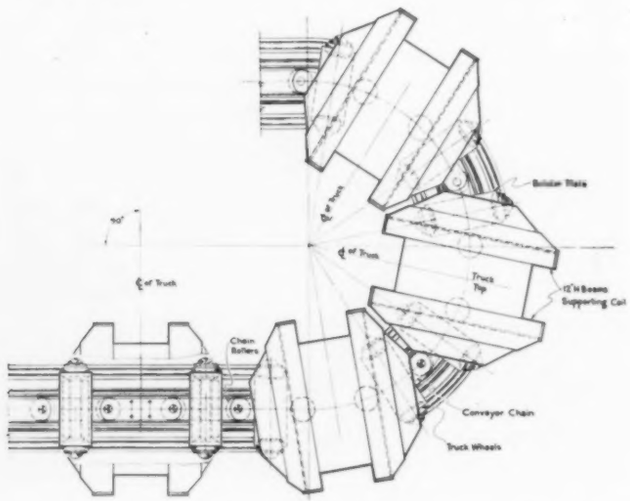
The development of the present day hot coil conveyor is the result of a sort of evolution beginning many years ago with a pair of heavy parallel chains sliding on greased tracks, and because of sliding friction was limited to about 100 ft in length.

In the attempt to overcome excessive friction, the next step was to use a pair of draw bench type chains, each running on a narrow bed of ball bearing rollers spaced close together. This design did not prove very successful due largely to the number of parts required, and excessive maintenance.

The third, and one of the present hot coil conveyor designs, is based on the conception of incorporating the friction reducing element into the construction of the chain itself. This idea has proved very satisfactory and made possible increasing conveyor length from 100 to 1000 ft or more with a single drive, a vast decrease in maintenance, and an increased capacity figured in tons instead of pounds. However, the original basic idea of two parallel chains supported on two continuous girders spaced 30 in. apart on centers to allow the arm of the

Figure 3 — Shown in this view is a portion of the carry-all hot coil conveyor at Weirton Steel Company consisting of single roller bearing chain and spaced 4-wheel trucks operating in a horizontal plane. Loading and unloading is simultaneous.

Figure 5 — Carry-all conveyor, while making 180 degree horizontal turn, has truck axles radial with the center of the curve.



down-ender to pass through, has never been changed.

In this third development of the two parallel chain type of hot coil conveyor, see Figure 1, the chain pitch is usually 12 or 18 in. with flat tops 6 to 8 in. wide. Every pitch is equipped with 7 in. diam x 3 in. face roller made of 5150 steel, heat treated and hardened to 60 Rockwell, and equipped with precision roller bearings. This type of chain weighs about 100 pounds per lineal foot. It runs on a wearing strip of spring steel and has an ultimate strength of 250,000 lb. The size of roller and pitch of chain given here is not fixed. They can vary either up or down to suit conditions. The chain can readily be disassembled.

This type of chain is also made with out-board rollers, as shown in Figure 2. This gives it the appearance of greater stability but twice the number of rolling parts and occupies a wider space in the cross-section. In all other respects it is like, and operates the same as, the chain with the single roller described above.

Almost invariably a hot coil conveyor system must make a right angle turn. This is not possible with the two parallel chain type of conveyor which can only run in a straight line and in one direction only, and a separate mechanical unit must be interposed to receive the coils from one conveyor and deliver to the one running at a 90 degree direction, or any other degree found necessary.

This transfer is made in two ways: by a combination of a short chain and gravity rollers, or by means of a lift and turn-around which lifts the coil from one conveyor, turns 90 degrees and lowers the coil to the other conveyor.

The transfer can also be made either 90 or 180 degrees by means of motor driven tapered rolls. This type has been satisfactory for the heavier gages, but it consists of many parts and is rarely used in the more modern layouts.

In Figure 3, is shown a comparatively new and basically different type of hot coil conveyor, only one of which is in operation—others are in the course of construction. It consists of a single endless chain running in a horizontal plane and attached to 4-wheel trucks at evenly spaced intervals of about 6 feet. It has a capacity of 2 coils per minute or 120 per hour. It can accomplish a number of results not possible with the two parallel chain design previously described. They are as follows:

1. It runs parallel to the run-out table and receives coils from the side alternately from each coiler by means of retractable up-enders.
2. It is unloaded from the side at any selected point by means of one retractable down-ender or by magnet cranes.
3. Coils on evenly spaced cars are automatically unloaded simultaneously with loading operations, and down-ended to rest on their sides on an auxiliary conveyor with spaced "V" shaped pockets.
4. The conveyor can double back on itself to provide cooling time where space is limited.
5. The conveyor length is made unlimited by the use of multiple caterpillar drives.
6. The conveyor is reversible, can run in either direction by means of caterpillar drive. See Figure 4. Pivoted dogs opposed to each other while engaging the chain rollers, insure accurate positioning of 4-wheel trucks for loading and unloading.
7. No transfer of any kind is necessary at a 90 degree turn, or a horizontal turn of any degree, anywhere, from loading point to coil storage or to any other place where they are to be delivered.
8. Danger of scuffing thin gage strip is completely removed. There is positively no movement of the coil while on the car, or sliding action while loading the conveyor.
9. Chain construction can be made so that the conveyor can rise in a vertical plane at an angle of 7 degrees from the level travel.
10. Construction of chain automatically takes care of expansion and increased length.

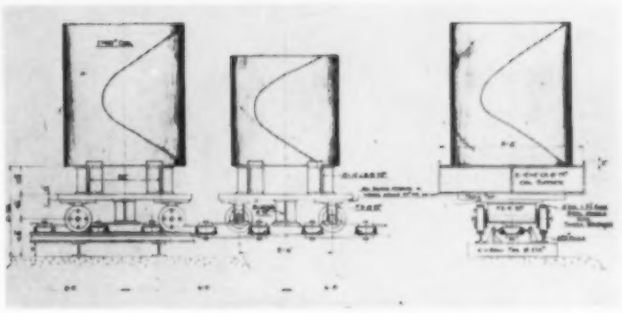
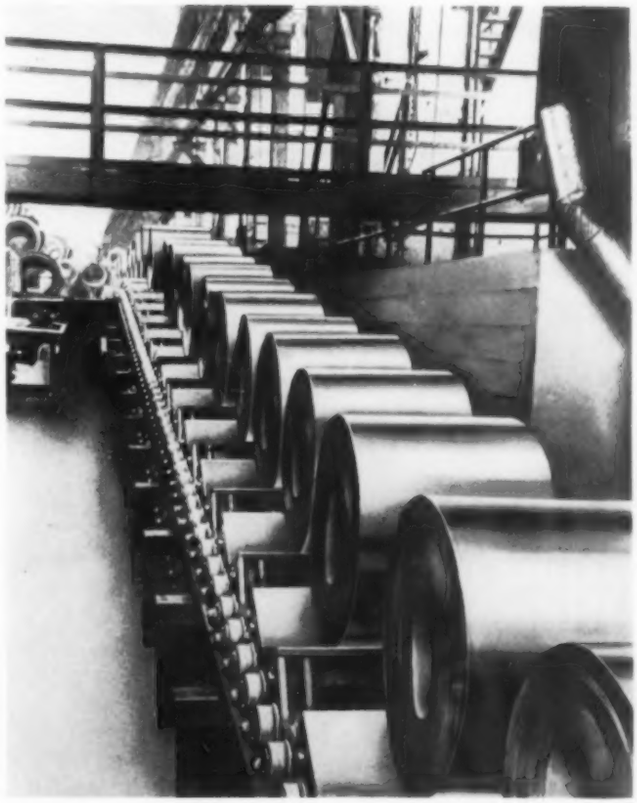


Figure 6 — Side view and cross-section of carry-all coil conveyor.

For the reason that the construction of this type of conveyor may not be readily understood at a glance, the author will give the following brief description.

The chain joint pins are in a vertical position to per-

Figure 7 — "V" shaped pocket conveyor transferring hot coils from carry-all conveyor to mill room floor and storage. Chain rollers are drop forged steel.



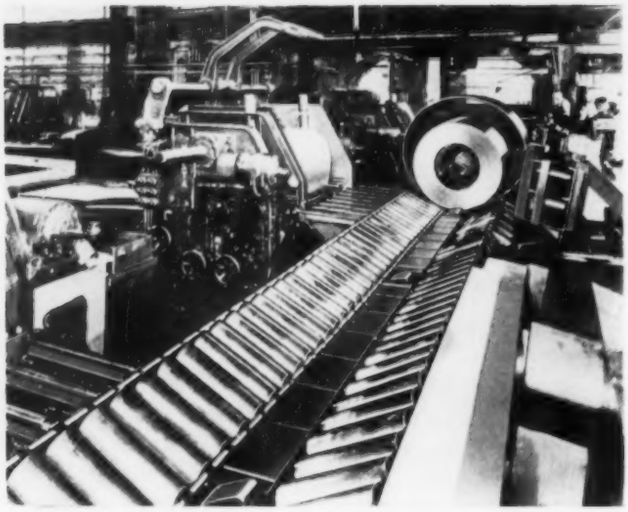


Figure 8 — Coil conveyor in front of pickle line at Great Lakes Steel shows the driving chain in the center and pusher dogs that can pivot sideways without injuring the coil.

Figure 10 — This conveyor is 575 ft-0 in. long and transfers coils from pickle line to cold mill at Weirton Steel Company.

mit the chain to flex and the conveyor to operate in a horizontal plane. The chain rollers are large in diameter and fitted with tapered roller bearings to minimize the friction in passing around the horizontal turns.

The cars are each equipped with four wheels which straddle the conveyor chain and are rigidly attached to it at spaced intervals. The car wheels are 12 in. in diameter, provided with tapered roller bearings and are made without flanges. All guiding of the conveyor is done with the chain rollers between two fixed rails.

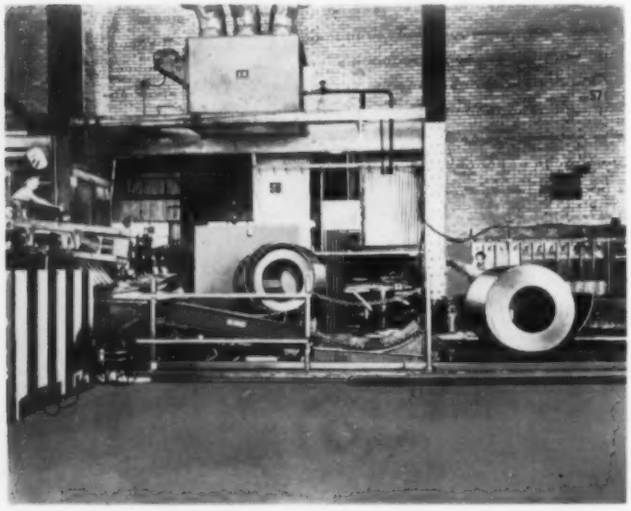
The axles of the trucks, as shown in Figure 5, while on the curves, are always radial with the center of the curve, thus allowing free wheeling, preventing chatter of the truck wheels, and insuring smooth running. Entering and leaving the curves there is a slight sliding action at the tangent points between the under side of the car top and the top of the bolsters. This is a negligible friction and the weight only amounts to about 40 psi for a 30,000 lb coil. The expansion and stretch of the chain is automatically taken up by telescoping effect provided in the chain joints between the trucks.

Figure 6 shows the car top which consists of a heavy plate forming a platform on which are mounted two wide flange beams of such height and spacing that the arm of the down-ender can pass between the beams on which the coil is to rest. This car top is attached rigidly to the top link of the chain by means of a center-post also attached rigidly to the car top. The front and rear of the car top plate each rest on top of a bolster attached to the chain, so that the entire load is transferred through the bolster and axle to the four flangeless wheels. No pressure comes directly onto the chain.

Coils of strip from the hot mill are stored in some plants on end, and in others on their sides. When stored on their sides, they are down-ended and automatically delivered to a conveyor with "V" shaped pockets spaced so that the maximum size coils will clear each other. These pockets are shown in Figure 7.

The transfer to this conveyor is usually made in the lower level and the conveyor brings the coils to the mill floor level and delivers to coil storage.

Figure 9 — Coils are automatically lowered from high level in front of pickle line to low level of conveyor on mill room floor.



THE COLD COIL CONVEYOR

The high speed of the modern cold reducing mill, together with the desire for a minimum number of stops to introduce new coils into the mill, has created a demand for cold coils of greater size. The cold coil as it comes from the continuous pickler has reached the weight of 70,000 lb. It comes from the pickler in a horizontal position, and is handled in that position throughout its travel to the cold mill where a supply of coils face the mill on a power conveyor for quick feed to the mill.

There are various methods of handling coils between the pickling operation and the cold reducing mill. One or two popular methods which will be confined to the taking of coils away from the end of the pickle line and showing them again as they enter the cold mill will be described. The intervening travel varies greatly to suit the layout of each individual mill.

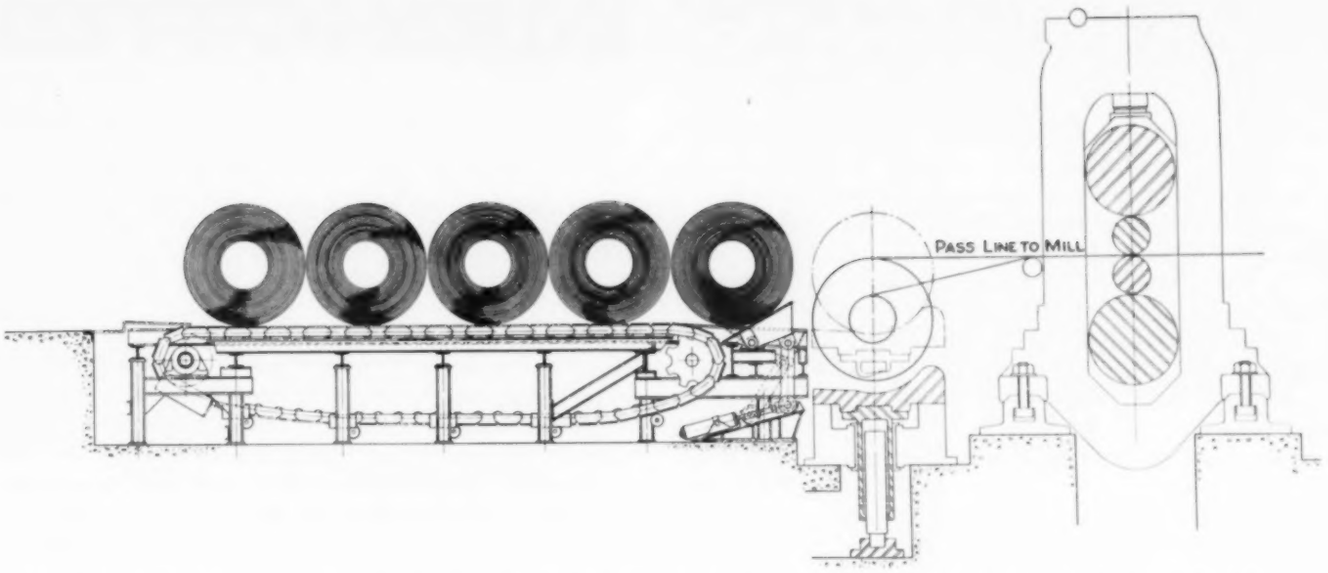


Figure 11 — Feed conveyor is delivering cold coils to mill with hydraulic operated safety stop in front of feed box.

As the coil discharges from the pickle line, it rolls by gravity onto a section of troughed roller conveyor mounted on heavy pre-compressed springs to take the shock. The coil is conveyed through the troughed roller line by means of a single chain equipped with knock-over pusher dogs. The conveyor rolls are 7½ in. diam. equipped with tapered bearings, and each roll has a capacity of 30,000 lb. See Figure 8. Knock-over dogs are so constructed that they can be pushed over sideways if they should be in the way of the coil as it comes from the pickle line. The chain and dog slides under the coil and the next following dog engages the end of the coil.

In this particular instance the coils leave the long troughed conveyor at one end by means of a side tilter mounted on a weigh scale.

When weighed they are automatically delivered onto a 4-strand chain storage conveyor 150 ft 0 in. long at floor level as shown in Figure 9. This is accomplished by means of a lowering device and a safety stop as indicated by the photograph. A lift truck unloads the storage conveyor and distributes the coils to the various feeder conveyors throughout the mill.

In another installation the coils from the pickle lines have a long way to travel to the cold mill. As they come from pickle lines, the coils are side tilted onto a conveyor 575 ft 0 in. long, traveling overhead to save mill room floor space. See Figure 10. It spans the distance between the pickle lines and a 5-stand mile-a-minute tandem mill. This conveyor has a distributed load capacity of 780 tons and can deliver 7200 tons per day of 8 hours.

The final travel of the pickled coils is on feeder conveyors to the various mills and processing operations. These include:

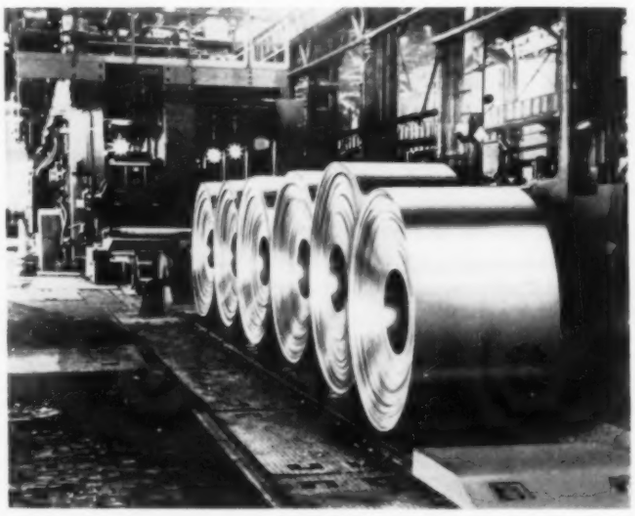
1. Entrance to the pickle lines.
2. Entrance to the cold reducing mill.
3. Entrance to the skin pass mill.
4. Entrance to the temper mill.
5. Entrance to the shearing lines.

The feeder conveyor (Figures 11 and 12) is either the multiple chain or platform type, about 20 to 30 feet long, built close to floor level and has a capacity of 6 to 8 coils, depending on their diameter. A hydraulic operated safety stop is located at the delivery end of the feed conveyor and delivers each coil to the feed box of the mill as shown on drawing.

The mechanical handling by chain conveyor of either hot or cold coils of any size or weight can be readily done. Where shocks occur such as happens when handled by magnet crane or gravity discharge to the conveyor, provision should always be made for shock absorption by spring mounted supports and bumpers.

With unfilled automobile orders stretching out for two years or more, to say nothing about all other industries requiring strip steel, the various types of coil conveyors will be required to handle enormous tonnage through the years to come, which they can do safely, smoothly, synchronized with production, and without damage to the product.

Figure 12 — Feed conveyor in front of "mile-a-minute" cold mill.



MAXIMUM INGOT YIELD

. . . . in order to obtain maximum yield, care and planning are required for every step between the ingot and the finished product . . . .

▲ PLANNING plays a very important part in most phases of modern industry. This is particularly true when converting steel ingots into rolled products.

The first phase of planning in the rolling mills is to determine the ingot size and weight that will ultimately produce a specified finished product with minimum loss. The ingot weight is computed from the desired weight of a particular product plus the losses sustained through the various conversions.

In rolling conversions, there are losses from crops that have to be cut to free the rolled product of pipe, and there are losses from crops necessary to square up the ends which have been laminated or distorted during rolling. Oxidation loss is also calculated for each heating cycle in determining ingot weights. For each particular heating cycle, the oxidation losses remain reasonably constant. They can be decreased, but due to the fact that reasonable oxidation in carbon steels is considered a necessary evil in clearing up minor ingot surface defects, it is questionable whether or not it is wise to attempt to minimize these losses. We believe that the oxidation acquired through heating carbon steels, in as near perfect combustion mediums as possible, to desired rolling temperatures, should be accepted as an all-around efficient operation.

The major loss in planning ingot weights is the crop which is necessary to clear the steel of pipe. The pipe formed in casting ingots is not directly proportional to the poured height. Therefore, to attain a minimum crop loss due to pipe, a maximum practical ingot height should be used which will satisfy weight requirements. We say practical ingot height because of limitations due to metallurgical reasons. Pipe formation also varies with different grades of steel; therefore, it is necessary to develop the crop for the various grades of steel in order that ingot weights can be so planned for each grade as to produce maximum yield.

The minor crop losses are the ends that have to be cut off due to lamination or distortion during rolling operations. The number of these crops that have to be cut depends on the number of multiples into which the ingot product is cut to satisfy the length limitations of the mills involved in converting the ingots into the finished material. It can readily be seen, that if these minor crop losses are to be kept down to a minimum, as few as possible multiple lengths of the ingot product should be cut throughout all rolling conversions up to the finished product.

The most efficient sizes and shapes of ingots for blooming into definite size products for the next rolling conversion are usually determined empirically. Ingot sizes must satisfy weight requirements and the ingots must also be easy to manipulate during rolling operations. It is also important that they roll into products having a minimum of surface defects caused by ingot design. Properly designed ingots, when rolled into the required blooms or shapes, will produce these materials with even ends. Blooms or shapes, having uneven ends or fish tails, increase crop losses which decrease yields.

The importance of attaining ingot sizes and weights that will ultimately produce the required length of finished materail with maximum yield cannot be emphasized too strongly. Incorrect ingot weights result in random lengths of finished product. Random lengths of finished material usually have to be cut back to some shorter specific length, thereby decreasing yield.

After the proper ingot weights and sizes have been determined through extensive study, it is pertinent that the open hearths furnish the blooming mills with ingots as specified. It is imperative that every ingot be cast as near the specified weight as possible. Average ingot weights are not sufficient if maximum yields are to be attained in the conversion of ingots into finished products.

The mills rely on the open hearths, not only for correct ingot weights, but also for ingots which are as near perfect as possible. When we refer to ingots as near perfect as possible, we mean ingots having a minimum of natural defects; such as, pipe, blow holes, segregation, and coarse crystallization. We also include other defects, namely, checking, scabs, etc. It is necessary to keep these ingot defects to a minimum because when they are apparent in the finished product, the products are rejected, thus decreasing the yield.

Up to this point, we have discussed the fundamental factors in accomplishing maximum yield before the steel ingots are actually processed in the rolling mills.

Ingots are delivered from the open hearths to the blooming mill soaking pits where they undergo the first heating cycle. In recent years, soaking pits have come into the limelight of steel processing. Today mill men realize that there was some truth in the favorite expression of open hearth operators: "We make good steel and it is mutiliated in the mills!" Unbeknown to mill men, some of this so-called mutilation did take place in the blooming mill soaking pits. Ingots were underheated, overheated and unevenly heated, resulting in inferior products for which the open hearth men were often criticized.

Thus, during the past few years, the importance of good heating in accomplishing maximum yields having been recognized, intensive studies have been made of blooming mill and soaking pit capacity. These studies have sometimes resulted in more pit capacity to satisfy necessary ingot heating time which is essential in producing required ingot temperature throughout the mass of steel. Many different types of soaking pits have also been developed. Each different type of soaking pit has its own merits. We believe that good heating can be accomplished in practically all modern soaking pits, if they are operated with proficiency.

Knowing the importance of proper rolling temperatures and even heating, which are difficult to accomplish with manually controlled soaking pits, auto-

Presented before AISE Buffalo District Section Meeting, March 9, 1948

BY PROPER PLANNING

By W. G. SMITH
Superintendent, 44 in. — 32 in. Mills
Bethlehem Steel Co.
Lackawanna, N. Y.

matically controlled pits have been developed. Fully automatically controlled soaking pits maintain even pit temperatures, desired pit pressures and proper combustion. Under such conditions, ingot temperatures can be attained to a degree of efficiency which is unattainable if human judgment alone is depended upon. They are absolutely necessary if we are to approach the desired temperatures as nearly as possible and reduce the losses due to overheating or burning of ingots. Automatic pit controls also increase the life of soaking pits because excessive temperatures are avoided.

Perhaps it will be asked: "What has the life of soaking pits to do with yield?" It has a great deal to do with it, for with their excessive costs it is impractical to maintain more soaking pits than are needed to meet the average requirements of the blooming mill.

Therefore, it is essential to keep them in good operating condition for as long periods of time as possible. Generally speaking, when there is a deficiency in soaking pit capacity, there is a tendency in all blooming mills to cut corners on heating. Whenever this happens, yields are bound to decrease.

In conjunction with good soaking pit practice, there are two other essentials. The first is that soaking pit bottoms must be maintained free of slag. The second is that ingots must not be crowded into soaking pits. They must be spaced properly so that all surfaces are heated evenly throughout the heating cycle.

Evenly heated ingots, going into the blooming mill, where the first rolling conversion takes place, can be easily reduced to blooms free from rolling defects. This cannot be said about unevenly heated ingots. When unevenly heated ingots are reduced in the bloomer, the hotter sides of the ingots elongate more than the colder sides, resulting in cambered blooms. When such blooms are entered into a box pass, they crowd the collars and the collars cut into the metal, causing collar marks. These marks often result into laps or seams after the blooms have been reduced to the specified size.

There is one other condition which arises when there is a marked difference in temperature on the ingot surfaces. These points are vulnerable to tearing during rolling operations and here again yields are lowered.

Even when ingots are properly soaked at the correct temperatures, a great deal of damage can be done in the blooming mill due to improper working of the ingots. The first step in the proper processing of ingots is the taking of light drafts on the ingot surfaces before any appreciable reduction is made. Such light drafts refine the ingot surfaces and they are not so apt to tear when greater reduction takes place. During the breaking down of the ingots, it is important that they are turned frequently. If too much work is performed on two surfaces without turning, the sides being spread will develop small crevices which often result in seams after the next rolling conversion. If they are present on the finished product, rejections will be high and yield low. Uneven working of ingots also aggravates ingot defects and increases rejections.

Blooming mill rolling failures often occur because of improper alinement of the rolls. If the rolls are not properly set up, the material is liable to turn in the rolls, resulting in cobbles. Special precautionary measures must be taken by rollers to prevent cobbles in the blooming mill because the loss of full ingots reduces yield very rapidly. Misalinement of rolls also causes collar marks which often roll into seams or laps on the material.

Once again, even specified ingot temperatures come into play during rolling operations. It is necessary that the ingots going into the blooming mill, to be rolled into a particular product, enter at approximately the same temperature. If there is a marked variation in temperature, from ingot to ingot, it is impossible for the roller to hold the section accurately and uniformly.

If blooming mill products are not consistent in size, it is impossible for the shearman to cut the required product lengths as planned for maximum yield. In order to be assured that the blooming mill product is the correct size, we cannot rely upon the calipered dimensions of the hot material. Trial bars must be rolled, cut to length and then weighed, until all the planned figures are satisfied. This, of course, includes the necessary crops to clear the top of the bloom or shape of pipe, and the bottom end from lamination and distortion.

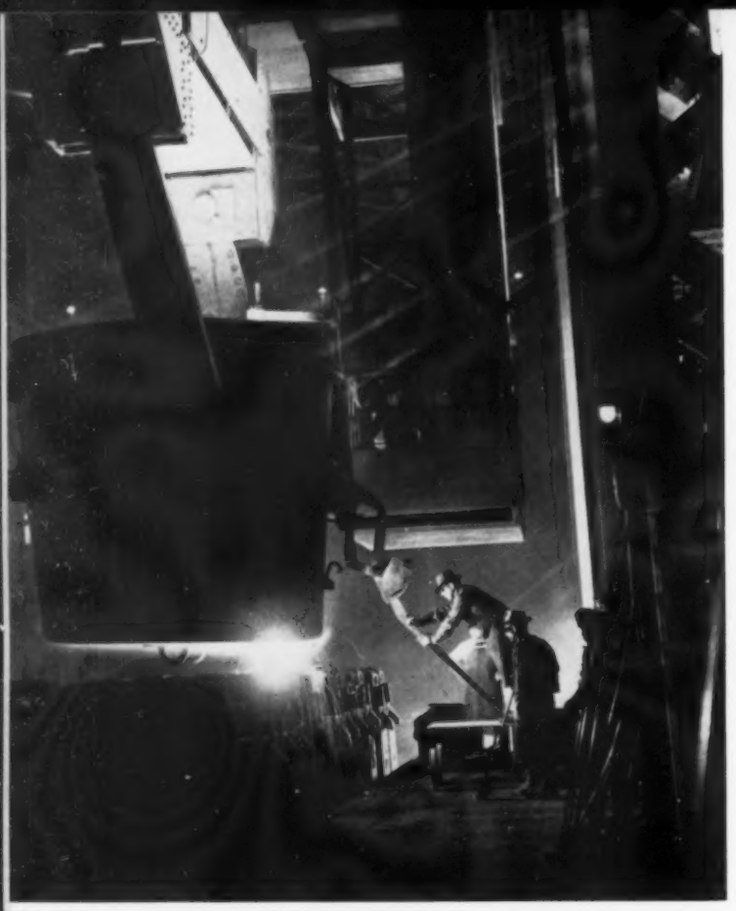
Care must be exercised at the blooming mill shear in cutting out piped steel. This is especially true if these shapes or blooms are to be rolled into sections similar to piling bar or some structural sections that develop long fish tails during rolling. If these fish tails have piped steel, quite frequently they will open up and catch a guide or other mill equipment, resulting in cobbles that decrease yield and delay the mill.

Blooming mill products are further processed by various procedures, depending on the size, shape and quality specifications of the finished or semi-finished material. One procedure is to roll the blooming mill product directly into finished or semi-finished product with only the heat that is retained in the material from the soaking pits. It is obvious, that if high yields are to be obtained in the rolling conversion following this procedure, ideal open hearth and mill practices must be followed.

The second procedure is to machine-scarf the blooming mill product before it is rolled into a finished or semi-finished product, without furnace reheating. Machine scarfing does eliminate minor surface defects. Nevertheless to minimize loss, good judgment must be exercised as to the degree of scarfing necessary for the particular products that are machine scarfed.

The third procedure is to chip or scarf the blooming mill product and then reheat it before the next rolling conversion.

The fourth procedure is to reheat the blooming mill product without any surface conditioning other than



Perhaps the simplest way of increasing steel production, because no additional facilities or raw materials are required, is to increase yield of finished product from the ingot. The steel industry in the United States has been very successful in so doing, particularly since the end of the war.

the furnace oxidation, before the next rolling conversion. This procedure is usually followed in producing materials that would finish rolling below a practical temperature if processed from a bloom or shape having only the retained soaking pit heat. Other conditions, such as finishing mills or billet mills remotely located from the blooming mill, make it necessary to reheat before further processing the bloom or shape.

In the last two processes, the same as in soaking pit heating, the reheating is a matter of great importance in accomplishing high yield in the succeeding rolling conversion. Compared with hot ingots, the nature of heating is very different, for here, all the heat is conducted toward the center from the exposed surfaces. Then, too, all the surfaces are not exposed to the same heat, hence there is a natural tendency toward uneven heating in these mediums. Uneven heating results in a variation in the dimensions of the rolled material, the same as mentioned in uneven soaking-pit heating.

There are several different designs of reheating furnaces. The same can be said about these furnaces as was said about the different soaking pit designs. If they are operated proficiently and if they are equipped with automatic controls, good results can be attained with little loss in yield due to heating.

A great deal can be said about the indispensable proficiency that must be accomplished in the reconditioning departments. Reconditioning departments are usually the bottlenecks of the rolling mills division. In fact, the machine scarfer was developed principally for this reason. In the reconditioning departments, the steel is classified according to the surface defects that have to be removed, so that the next rolling conversion will produce a specific quality product. This is not any easy task. If more defects are removed than is necessary to produce a particular quality product, the efficiency of the department suffers. If certain defects are not removed, which should be removed according to the specification, rejections will increase and yields will be low. Consequently, it can readily be seen that if maximum yield and efficiency are to be attained, the reconditioning departments must be "on their toes."

Many semi-finished materials or billets rolled from blooming mill products are also surface conditioned by chipping or scarfing before being rolled into smaller articles, such as merchant or bar mill products.

In attaining maximum yield in billet mills, the products must be rolled to specified size, weight and length, as planned. These specifications are met by trial bars that are accurately measured for all dimensions and then checked by scale weights. This is of major importance in avoiding random lengths of finished products.

Again heating comes into the picture because, if billets of accurate size length and weight are to be rolled, evenly heated material must be supplied to the billet mills.

Billet mill rollers must have the necessary technique to avoid cobbles and produce billets free from mill defects. Cobbling is a frequent mill failure. Cobbles usually occur at the beginning of a section change. If rollers are careless in their guide and roll set-up, low yield will result from mill cobbles.

Quite frequently, when billets are found to contain defects, such as laps, seams, scratches, slivers, etc., rollers are reluctant to stop the mill. They try to eliminate the defect while rolling at capacity. This practice is wrong. If maximum yield is to be attained, the mill must stop rolling as soon as defects are discovered, so as to minimize defective material. The correct practice is to roll one piece of material at a time until the defect has been eliminated. Even though billets are to be reconditioned before the next rolling conversion, the goal should be to produce billets with a minimum of surface defects.

Finishing-mill rollers must also follow the same practices as cited for producing billets with maximum yield. In addition to this, the finishing rollers have much closer tolerances to which they must work in satisfying rolling specifications.

The requirements of the finished products in the many types of finishing mills vary greatly. Nevertheless, the different finishing mill rollers have the same defects to combat, such as overfills, buckles, underfills, slivers, seams, laps, firecracks, roll marks, etc.; although there is a variance in the degree of these defects that will be allowed on different finished materials. It is up to the rollers to know the defects that either will or will not be accepted on a particular first quality product. Poor judgment on the part of the finishing roller may result in the rejection of tons of finished material. It is obvious that, when this happens, yield will be low.

We have mentioned in this paper that mill failures, resulting in cobbles, occur most frequently when start-

ing up on a particular section. This is true because it is improbable always to set up the mills in such a manner that the first product rolled is passable material. It is logical that, if these mill failures are to be minimized, large orders on each mill section should be obtained whenever possible before rolling the section and all equipment must be adequately maintained, both electrically and mechanically.

We must also not lose sight of the fact that perfect finished materials can only be produced with rolls and guides properly designed. This is a study in itself and mill men must rely on roll and guide designers to furnish this equipment.

Maximum yield can be accomplished only by careful planning and diligent processing from ingots to finished products.

DISCUSSION

PRESENTED BY

R. J. BARRY, Superintendent, Bloom and Billet Mills, Steel Company of Canada, Hamilton, Ontario, Canada

W. G. SMITH, Superintendent, 44 in.-32 in. Mills, Bethlehem Steel Co., Lackawanna, N. Y.

O. K. SHARP, Superintendent, Blooming and Billet Mills, Republic Steel Corp., Buffalo, N. Y.

W. C. THIRY, Field Engineer, General Electric Company, Buffalo, N. Y.

R. J. Barry: I would like clarification of the statement as to how slag in the soaking pits affects the yields.

W. G. Smith: Maybe you have not seen soaking pit bottoms in the same condition as I have observed them. I have seen soaking pit bottoms that were quite low and in a molten state. If you are operating soaking pits with low bottoms and molten slag, the slag will eat into the bottom surfaces of the ingot and ultimately decrease the yield. Normally there should be a very low percentage of crop from the butt of the ingot. Usually when a bottom is in a low and molten state it is difficult to get even heating on the bottom ingot surfaces, and when you do not have even heating you are bound to get some cracks which will finally end up in rejected product.

R. J. Barry: When you say "bottom," what do you mean?

W. G. Smith: Coke bottom.

R. J. Barry: In other words, I think the dry bottom gives you a better yield. If you use a dry bottom on your soaking pit, you get away from that bad condition on the butts of ingots.

W. G. Smith: That is right.

W. C. Thiry: In clearing up defects on the ingot, is it oxidation or is it actual melting? To what extent does the soaking pit clear up the surface of the ingot? Is it just due to oxidation alone?

W. G. Smith: That is what we have always figured. Some people do wash their low carbon steel before drawing it. We never do, as we never thought it was good practice. We believe that the clearing up of the surface defects on the ingot should only be from oxidation.

H. F. Marquardt: We do have some problems at our place and I feel Mr. Smith probably has the same. He might answer this one. Let us say that the final usage is a three and a half inch or four inch round. For this, I imagine you would use a six by six or seven by seven billet. If now, you were getting 9000 or 9200 pounds of good product and another customer came in, where it would be very desirable to get about 9400 pounds of product, in what manner might you go about getting 200 more pounds out of the ingot? Assume hot top ingots.

W. G. Smith: There are limitations, but I believe that everyone follows the same practices, that is, if they need a little more weight they will block the hot top up one, two, or three inches to get the additional weight. There is this limitation in using this method. You must have a specified hot top volume for the particular quality steel you are making. Therefore, on some quality steels you might not be able to fulfill this requirement.

H. F. Marquardt: We have another problem I do not know whether or not your mill produces the smaller billets such as 1¾ or 2¼ in. billets. Usually I believe your furnaces take a 30 ft billet the same as ours. You are cutting 30 ft billets, and you are probably getting 20 or 22 out of the ingot, whatever the number, on the tail end you may have 34 or 35 ft left. Do you discard four or five ft or do you cut 2 shorts?

W. G. Smith: If we have application for 4 x 4 in. billet shorts in the 12 in. mill they would be cut. We have no application for smaller billets under 25 ft long, therefore, extra crop would be taken from the top end, but that goes right back to the same subject that we have already discussed. If the open hearth poured the ingots to the weight that we order we will come out with the right length.

O. K. Sharp: You talked about ingot design and fish tailing, are you talking about the bottom on an open top or the big end up ingot?

W. G. Smith: Generally the top end of any type ingot will not fish tail enough to decrease the yield, but you can lose as high as two or three per cent on a bottom discard by using too large a mold for a particular section.

O. K. Sharp: Are you using any special stool design?

W. G. Smith: No.

Graham Wickizer: You were talking about your various ingot weights in which you get 5 or 6 rails per ingot. Therefore, the top of your ingots must be poured lower down in the mold on some rail sections than it is on others.

W. G. Smith: That is true.

Graham Wickizer: Do you find any relation between the per cent of discard necessary to clean up interior defect, and the distance from the top of the ingot to the mold top? In other words, do you find it necessary to crop off more steel to clean up the interior defect, when your ingot is 12 in. from the mold top, than is necessary when the ingot is within 4 to 6 in. of the mold top?

W. G. Smith: We have found that we must take a greater discard when we have a lot of unfilled mold above our ingot top, and when we do find it necessary to pour an ingot 10 to 12 in. down in the mold, we insist on additional topping off time for these ingots. We have found that this helps to reduce the discard necessary to clean up this interior defect.

ALLOYS AND THE

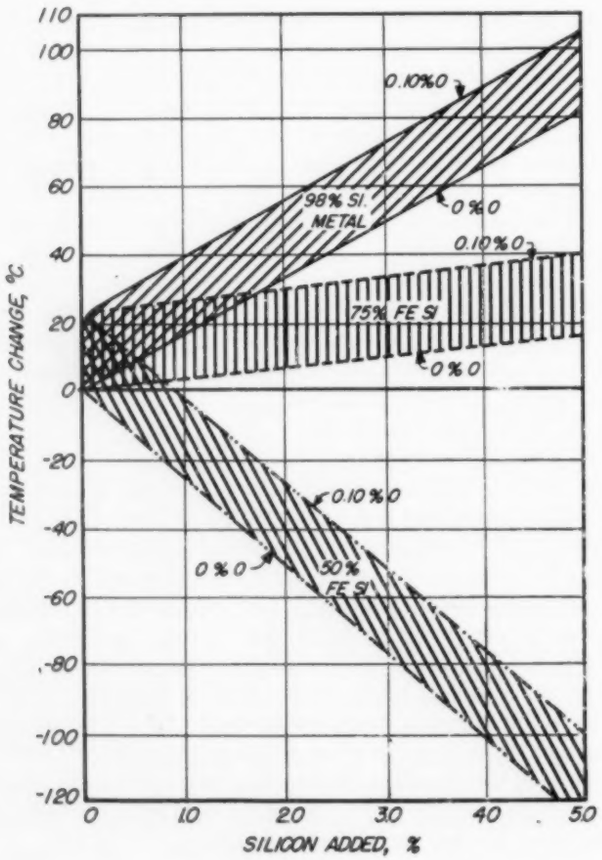
. . . . some alloying elements are added to steel as an aid to the process, and others for the effect on the final physical properties . . . .

▲ WHEN steel was first made, the greatest concern was to eliminate all the impurities contained in the crude pig iron and to make as pure an iron as possible. Some of the carbon was then put back in by carburizing, according to the strength or temper desired. Subsequently the steelmaker has had to concern himself with more and more elements. First it was sulfur, phosphorus, manganese, and silicon, then tungsten, chromium, nickel, vanadium, and aluminum, until now at least 36, or more than one-third of all the elements known, have to be considered somewhere in the process of making, shaping, or treating steel. Some of these elements we know to be beneficial to certain properties, others we believe are helpful (still under investigation, perhaps); some elements we know to be harmful, others we think may be harmful under certain circumstances, and still others appear to be blamed for want of the true cause. The alloy makers can hardly be blamed for this complex situation, however.

Alloys for the steel industry became important to the art almost as soon as the most significant step in steelmaking was taken, that of reaching the completely liquid stage, credited to Huntsman, the inventor of the crucible process in about 1770. In 1839, Josiah Marshall Heath took out his memorable patent for the employment of oxide of manganese in the manufacture of steel. Only eleven months after the granting of a patent to Henry Bessemer in 1856 for converting iron to steel by means of forcing cold air through the liquid iron, another patent was granted to Robert Mushet for eliminating hot shortness and cold shortness in steel by the addition of an alloy of iron and manganese. From then on manganese, first in the form of spiegeleisen (20 per cent manganese) and later as ferro-manganese (80 per cent manganese) also, was used as an aid in the steelmaking process. It was much later, after the turn of the century, that manganese came to be recognized as a valuable alloying element to improve mechanical properties.

Presented before AISE Buffalo District Section Meeting, November 9, 1948

Figure 1 — Temperature change caused by addition of silicon metal or ferrosilicon to molten iron at 1600 C. Heat capacity of furnace is assumed negligible. (From "The Induction Furnace as a High Temperature Calorimeter and The Heat of Solution of Silicon in Liquid Iron, By J. Chipman and N. J. Grant; A.S.M. Transactions, 1943.)



Perhaps the alloys next in importance to the steelmaker are the silicon alloys. Not many years after the necessity of manganese was generally recognized, it was realized that an alloy of iron and silicon had the effect of quieting a steel bath and eliminating blow holes during solidification. The growth in use of ferro-silicon was slower than that of manganese, since the disadvantages attending more complete deoxidation, such as deeper piping, were not easily overcome. This element also was later found to have important alloying effects in addition to its function of combining with oxygen during the steelmaking process. At the turn of the century, however, many steelmakers thought that silicon was harmful to steel, even in amounts as low as 0.03 per cent. The old idea that the purest steel is the best still prevailed.

The latter part of the nineteenth century saw the beginning of many developments in the steelmaking art. In comparison to the invention of the bessemer and open hearth processes, the birth of alloy steels may have seemed somewhat insignificant, and it is only comparatively recently that they have grown beyond the "specialty" stage. Slowly one element after another was added to molten steel and its effect on mechanical properties measured. First, a tungsten-containing steel was found to have the property of hardening while being cooled in air, and to make a better cutting tool than a simple carbon steel. Just a few years later chromium was recognized as being beneficial to the tensile strength of steel without greatly reducing its ductility. Nickel steels and vanadium steels were soon found to have other properties unobtainable in carbon steels.

STEEL INDUSTRY

By T. W. MERRILL
Metallurgical Engineer
Vanadium Corporation of America
Bridgeville, Pa.

This brings out a significant distinction between the various alloys used in steelmaking. On one hand we have a group of alloys which are used to improve the process by which steel is made, whatever the grade. On the other hand, there is a long list of alloying elements which are added to steel to alter its properties in one way or another. The former are often called process alloys and the latter addition alloys. We are making this somewhat arbitrary distinction here to help clarify the function of the alloying elements. Process alloys were recognized first, grew in use faster, and have always been demanded by the steelmaker in much larger quantities than addition alloys. Of the now quite larger production of ferro-alloys, about 90 per cent is made up of the alloys of manganese and silicon. While these alloys are used both as process and as addition alloys, the large part is for the former use.

Although the rapid growth in the use of process alloys to a larger extent accompanied the increase in steel production, the use of addition alloys has become much greater because of the demand for more and more steels with better properties than are obtainable with carbon steels. Steels to resist corrosion, elevated temperatures, wear, and especially steels having great strength and toughness, are being demanded to meet more severe applications. One example is afforded by the change in the design of steam locomotives. Plain carbon steel with comparatively low strength has always given very satisfactory service as boiler plate until more modern design called for higher steam pressure with consequently higher stresses in the boiler plate. Alloy plate steels are being used in locomotives to some extent and perhaps will be used even more as a result of these conditions.

Concurrently with the constant improvement in the quality and mechanical properties of steels of all grades through the use of alloys, there has been an increase in the purity and the effectiveness of the ferro-alloys themselves. As the art of steelmaking has made great strides in the last fifty years, so has the art of ferro-alloys manufacture. Probably the greatest accomplishment has been the development of new alloys to accomplish specific tasks of the steelmaker. There is also a less widely known but very important effort to discover new raw materials and processes by which purer ferro-alloys can be produced in order that steels of higher quality can be made more consistently.

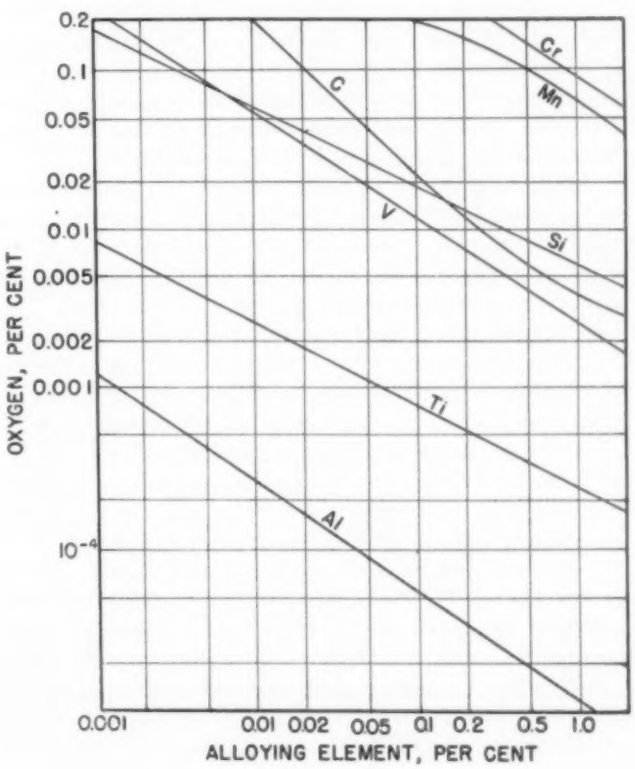
PROCESS ALLOYS

We propose now to review briefly the commonly used ferro-alloys with reference to the classification mentioned previously, and then to discuss some of the newer developments in this field.

Manganese and silicon are the two principal process alloys. They are added to the steel as ferro-manganese, ferro-silicon, spiegeleisen, and silico-manganese. These elements serve both as process alloys and as addition alloys. In the former role, manganese combines with the sulfur to prevent the hot shortness which can be caused by this element. Because all of our steels today are made with the proper manganese to sulfur ratio, this ever-present function is often forgotten. Manganese also acts as a deoxidizer, forming products of deoxidation which are less objectionable and more easily removed from the steel than those resulting from the use of silicon alone. This element also serves an important function as a slag component in open hearth practice. For deoxidation it is often added as ferro-manganese, silico-manganese, or as spiegeleisen, while the first one mentioned is the usual alloy for larger additions as an alloying element.

Silicon's principal role is that of a deoxidizer. It is added as 15, 25 or 50 per cent ferro-silicon to stop or control the oxidation of carbon in the bath in the open hearth process, and to combine with the oxygen in the steel for "killed" steels. The lower silicon grades are more often added to the furnace where their greater density insures penetration through the slag to the molten steel and where the chilling effect of a large ad-

Figure 2 — Equilibrium relation between residual deoxidizing elements and residual oxygen in steel. (From, "Basic Open Hearth Steelmaking," Chap. 16, by J. Chipman; A.I.M.E. Publication, 1944.)



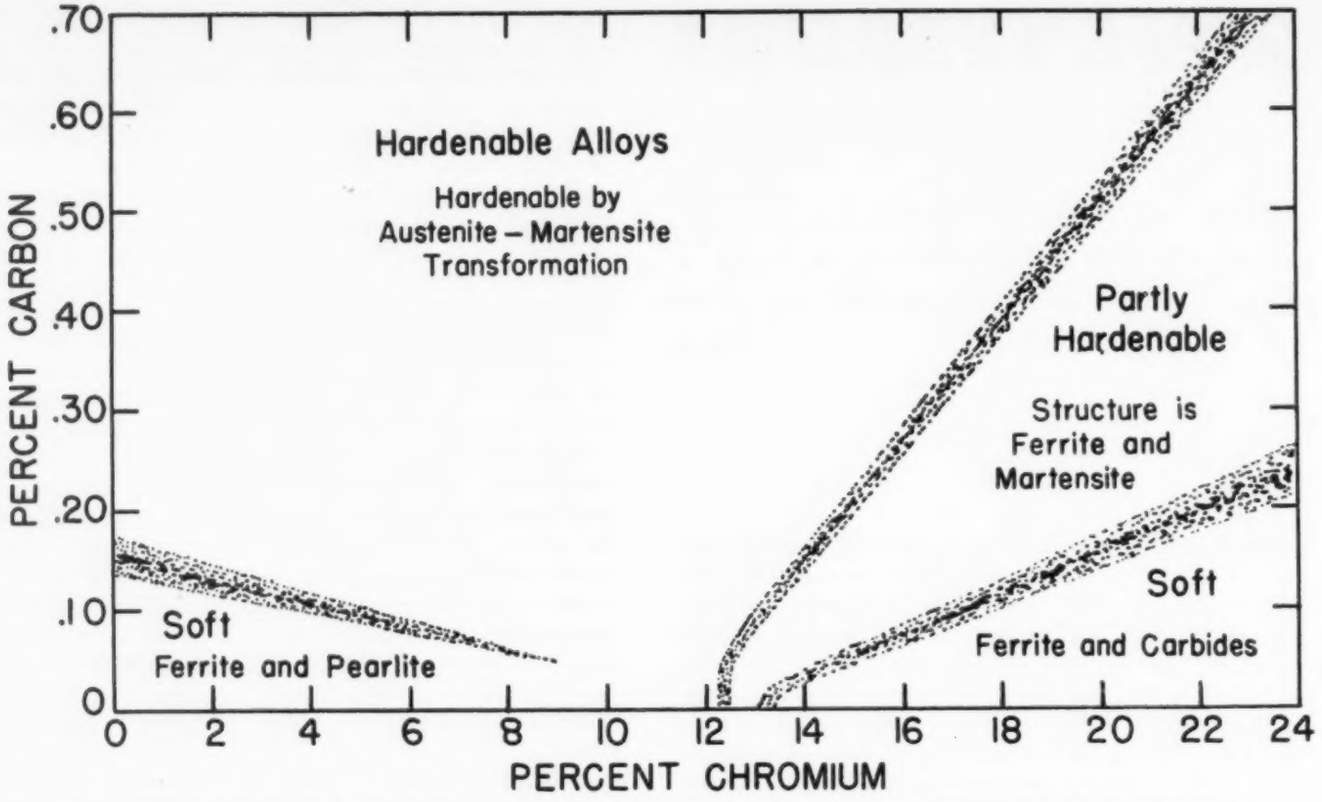


Figure 3 — Rough subdivision of chromium-iron alloys showing how carbon influences their hardenability. (From "The Book of Stainless Steels," by E. E. Thum, Diagram by E. C. Bain.)

dition is not as detrimental, while the higher silicon grades, 50, 75 and 90 per cent, are added to the ladle. Grades above about 75 per cent silicon actually cause an increase in the temperature of the steel when added to the ladle because of the heat of oxidation and the heat of solution of the silicon (Figure 1). Deoxidation practices are usually designed, however, to avoid retention in the molten metal of silicates formed by the combination of oxygen and silicon, since this hard material is objectionable in subsequent processing, especially machining. The use of silicon and manganese together, either as separate alloys or as the combination, silicomanganese, is said to avoid this condition.

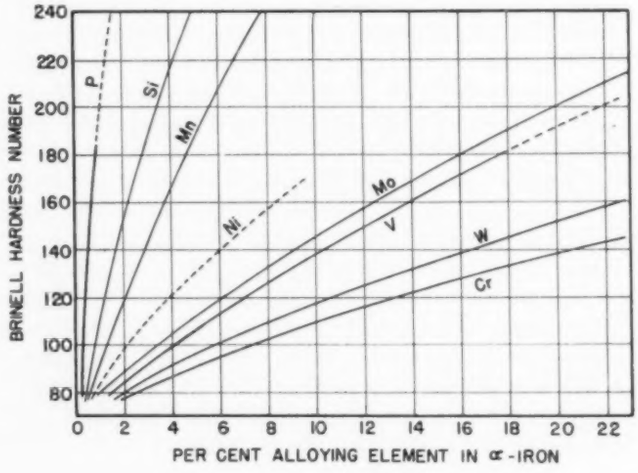
Aluminum is widely used as an aid to the finishing of the steel. It is a stronger deoxidizer than either manganese or silicon; that is, it removes oxygen from the steel to a greater extent. By its use easily oxidizable elements can be added subsequently with less loss. This use of aluminum is an old one, having been practiced for more than fifty years. The control of grain size with this element was developed at a much later date, but is now practiced in a high percentage of all killed heats to effect better mechanical properties (Figure 2).

Titanium is a very active element which combines with oxygen and with other gases, such as nitrogen, whose presence in the steel is undesirable. It is not as active in combining with oxygen as is aluminum, but it is considered to form a more stable combination with nitrogen. In certain low carbon steels titanium is added to combine with the carbon, thus preventing it from exerting certain undesirable influence on the properties of the steels during processing or during use, such as the stabilization of stainless steels against intergranular corrosion. Titanium forms a compound with sulfur to prevent hot shortness in much the same manner as manganese.

Zirconium is used to a lesser extent as a processing alloy to form compounds with undesirable elements, such as oxygen and nitrogen, removing them from the steel or forming particles of less objectionable shape. This element, often added as an alloy of silicon and zirconium is said to combine with sulfur, avoiding the latter's undesirable influence.

Vanadium is in some respects a processing alloy, although most of its uses are as an addition alloy. This

Figure 4 — Probable hardening effects of the various elements as dissolved in pure iron. (From, "The Alloying Elements in Steel," by E. C. Bain; A.S.M. Publication, 1939.)



element is used as a deoxidizer in only a few special cases, principally in making steel for large forgings. Its action as a grain refiner is more often taken advantage of, although it serves simultaneously as an aid to the mechanical properties. There are certain recognized advantages in the use of vanadium as a processing alloy as compared with aluminum, for example, and its greater use is limited only by its cost. A recent development in this respect is the use of a small amount of vanadium to prevent aging in rimming steels, apparently by combining with the nitrogen, thus permitting its use for deep drawing applications such as automobile fenders.

ADDITION ALLOYS

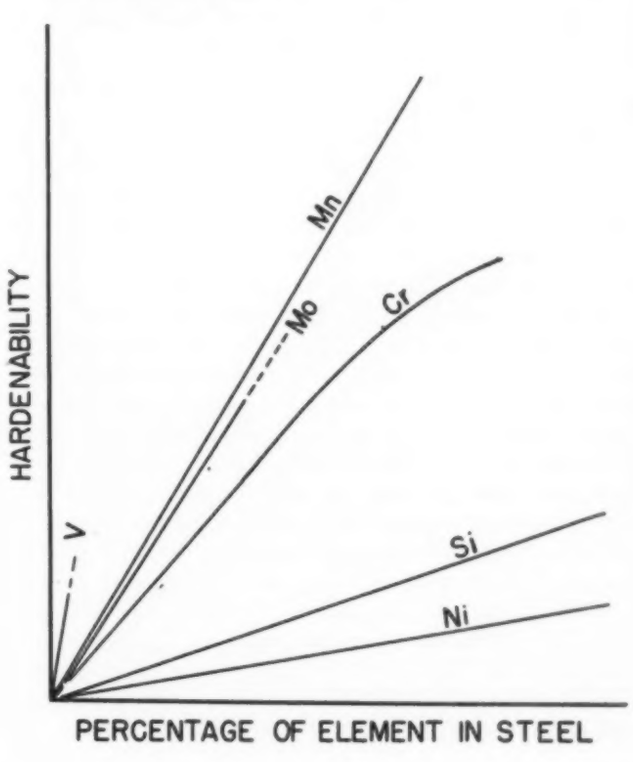
All of the previously mentioned elements, plus a much larger number of others, when added to steel in the proper quantities, influence the properties of steel in a certain fashion peculiar to that element and to the combination of elements to which they may be added. The behavior of these alloys, which we are arbitrarily calling addition alloys, is not completely known, and even if it were, this brief coverage could not possibly do justice to the subject. We will attempt only to point out some of the more obvious and interesting facts concerning the most commonly used alloys.

Chromium is added to steel, usually as ferro-chromium, in amounts ranging from less than 0.30 per cent to more than 30 per cent. Ferro-chromium is made in various grades ranging from less than 0.06 per cent to 6 per cent carbon content or more, to suit the composition of the steel to which it is to be added. Small amounts of chromium in steel permit greater hardening in a given size of piece and with a given heat treatment, resulting in greater strength. In special cases, particularly with high carbon steels, small amounts of chromium prevent graphitization when held for extended periods at elevated temperatures. At about 1 per cent, chromium increases the strength of steel even more, and in addition confers appreciable wear resistance.

A steel having just above 1 per cent chromium, with about the same amount of carbon, is the most popular bearing steel. It might be added, parenthetically, that bearing steel is required to be exceptionally clean, and consequently the quality of the ferro-chromium added to this steel must be very high. This is just one example of the tailoring of alloys to meet the needs of the steelmaker. In combination with other elements such as nickel, molybdenum, or vanadium, chromium, in this general range, is added to steels for a vast assortment of constructional uses. It is found in the best spring steels; it is used in many carburizing steels for automobiles and other types of machines; it is put in alloy steels for high strength shafting and for vital forgings. With chromium between 2 and 3 per cent, steels can be nitrided to exceptionally high hardnesses, have great resistance to softening at elevated temperatures, and will harden in heavy sections, such as armor plate. All high speed tool steels contain approximately 4 per cent chromium, in addition to other elements. Steels with 5 per cent chromium, plus molybdenum, are widely used for resisting the softening effect of exposure to elevated temperatures, such as high pressure boiler tubing. With still higher chromium content, steels possess the very advantageous property of being resistant to corrosion by various media. Steels with 9 per cent chromium are sometimes used, but at about 12 per cent the well-known stainless steel class begins, and it is unnecessary to speak further of them, except perhaps to recall that in addition to their resistance to many corroding media they have high strength and resist oxidation at elevated temperatures; and that those which are austenitic possess unusual toughness at very low temperatures (Figure 3).

Nickel affects steels in a much different manner than chromium. It is added to the steelmaking furnace as the metal itself without any losses by oxidation as with other additions. The beneficial effects of nickel have been known and used for many years. Ductility accompanied by a moderate increase in strength is probably the principal benefit realized from the usual additions. Nickel is found in steel in amounts ranging from about 0.50 per cent to more than 20 per cent, although alloys which contain 35 per cent or even 65 per cent nickel might be included in this classification. Small amounts in steels containing other elements add to the ductility and toughness. The so-called NE, or triple alloy, steels contain less than 1 per cent nickel and are manufactured in large tonnages today. In steels with between 1 and 2 per cent nickel, a moderate increase in strength with greater benefit to ductility is found. A great many nickel-containing steels have between 2 and 3 per cent nickel and possess very advantageous mechanical properties for many uses. Nickel is not a strong hardening element and, therefore, contributes less to sensitivity

Figure 5 — Relative effect of alloying elements on the hardenability of steel.



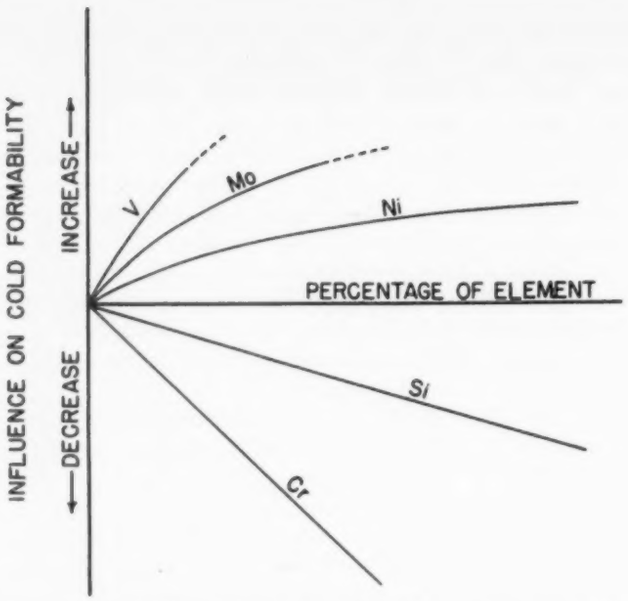


Figure 6 — Relative effect of alloying elements on the cold formability of steel. (From, "Selection and Conservation of Alloying Elements Used in Steel," by John Mitchell; Contributions to the Metallurgy of Steel, No. 6; A.I.S.I., May 1942.)

toward cracking from thermal abuse compared with equivalent quantities of other elements. The matrix of the steel is toughened by nickel, benefiting mechanical properties in all conditions of heat treatment, and perhaps the only significant disadvantage of this is the gummy condition sometimes observed when machining steels containing nickel as the only alloying element. See Figure 4. Nickel's toughening influence on steels at low temperatures has been used to advantage in such applications as parts of locomotives in northern climates, and, more recently, for storage and transportation of liquefied gases. Most stainless steels contain nickel from 7 to 10 per cent, and steels with only nickel, in amounts between 9 and 12 per cent are used for moderate resistance to corrosion. Heat resisting grades contain as high as 20 per cent (up to 65 per cent in other iron-nickel alloys).

Steels containing molybdenum became popular more recently than chromium and nickel steels, but its use is now quite widespread. The amounts used are smaller, usually ranging from less than 0.10 up to 0.60 per cent, in constructional type steel, but up to 9 per cent in tool steels. Calcium molybdate and molybdic oxide are the common forms of adding this element to steels, with ferro-molybdenum being used in certain instances. Molybdenum is essentially a hardening and strengthening element, but with many attendant advantages as shown in Figure 5. It increases the ability of the steel to be hardened, and thus strengthened, to a greater extent per unit quantity of the element present than chromium, nickel and most other elements, being exceeded by manganese and vanadium. Molybdenum is quite effective in toughening steel in the heat treated condition. It prevents the undesirable phenomenon known as temper brittleness possessed by some steels which become brittle after being tempered at certain temperatures and cooled at certain rates. Steels containing about 0.50 per cent molybdenum are extensively used because of the high strength possessed and maintained at elevated temperatures, frequently expressed as creep strength. Molybdenum is a constituent of many tool steels; ranging from much less than 1 per cent in the lower alloy cutting and die steels to more than 9 per cent in some high speed tool steels.

The effects of vanadium are complex and hence somewhat harder to describe in a few words. This element is used in amounts as low as 0.02 per cent and as high as 5 per cent. It is added as ferro-vanadium which is made in several grades differing in carbon, silicon and vanadium content. Because it is an active element with respect to oxygen and nitrogen, care must be given its addition to the steel. In amounts below about 0.07 per cent, vanadium is one of the strongest hardening elements. A very small amount has a proportionately large effect in raising the strength of steel, particularly when liquid quenched and tempered. Larger amounts of vanadium are especially beneficial in increasing the strength of steel in moderately large sections when cooled in air (Figure 6). Ductility and toughness of vanadium-containing steels are exceptionally good. The softening rate of steels, when held at temperatures within the usual tempering range, is appreciably slowed by the presence of vanadium, a valuable property in high strength constructional steels permitting an excellent balance between strength and ductility and in stress-relieved high strength welded structures (Figure 7.) Microstructures are more stable.

Vanadium is one of the very few elements that improves the weldability of steels rather than impairing it. Springs of the best quality have been of vanadium-containing steels for many years. The carbide forming tendency of this element favors its use where wear is encountered. There are many more tools made with vanadium than without it, from simple knife and chisel steels to die steels and high speed steels. The latter group of steels usually require more of the total production of vanadium than any other use. All high speed steels contain vanadium from 1 to as high as 5 per cent; without it modern cutting requirements cannot be met.

Tungsten has been used as an alloying element longer than any other. It was added to steels intended for tools, and later for magnets. Amounts ranging from less than 1 per cent to more than 20 per cent are encountered in various types of steels. Tungsten is used chiefly in the tool steel field, and in the smaller field of magnet alloys. All high speed tools contain tungsten; the most popular grade contains 18 per cent, plus 4 per cent chromium and 1 per cent vanadium. Many die steels and cutting tools for finishing operations contain appreciable percentages. Several grades of steel for springs and other parts to be used at elevated temperatures contain tungsten. There are not many steels having low percentages of tungsten, perhaps because its effect under these conditions is not sufficiently different from that of chromium or molybdenum to warrant the appreciably higher price. This element is added to steels as ferro-tungsten which contains about 80 per cent tungsten.

Copper is added to steel for the resistance to mild corrosion which it confers. Increased strength can be realized if the copper content is above about 0.70 per cent and if the proper heat treatment is given the steel

to effect precipitation hardening. Copper is used for this purpose much less than for its corrosion resistance, where 0.30 per cent is effective. It is to be noted that while small amounts of copper provide corrosion resistance to atmospheric attack to a much greater extent than small amounts of other common elements, larger amounts of copper are impractical because of its undesirable effects on mechanical properties, and do not begin to compare with the corrosion resistance brought about by larger amounts of chromium or nickel. The class of steels known as "low-alloy, high-strength steels" depend on addition of copper for their corrosion resistance. Copper also has the disadvantage of causing steels to become hot short to a limited extent where severe hot working is required unless other elements, such as nickel, are added also.

Titanium is an addition alloy in some of its uses. This is a very active element which always combines to some extent with the gases in the steel, thus acting as a process alloy at the same time it is intended as an addition alloy. There are high strength plate steels containing titanium which are being used rather extensively. Several grades of stainless steels contain rather large percentages of titanium. In these steels, and also in one grade of enameling sheet, titanium combines with the carbon to produce, in effect, a carbon-free steel, the carbon being present but practically inactive by segregation in large particles.

Manganese deserves more than just mention as an addition alloy since it is very effective in increasing the hardenability of steel, and consequently the ability to be made stronger with suitable heat treatment. In a sense manganese is the alloying element added to all carbon steels. There has been a gradual increase in the manganese content of many carbon steels, which is responsible for a very appreciable increase in their strength. This has allowed such steels to be used for many high strength applications which might otherwise require alloy steels. This is even more significant in consideration of the relative cost of ferro-manganese in comparison with other alloys (Figure 8). High manganese or Hadfield steel, 12 to 14 per cent manganese, with carbon 1 per cent or more, has long been popular for its high resistance to severe wear in applications such as heavy material handling equipment and railroad frogs and switches.

Silicon is used as a true addition alloy, by which we mean the addition of more than about 0.40 per cent, in comparatively few grades of steel. However, for the cores of electrical motors and transformers, high silicon steel is alone in the field. Its low hysteresis loss makes its use essential in all equipment of this type. There are also several grades of tool steel and spring steel containing 1 to 2 per cent silicon.

Columbium is a strong carbide forming element and is used principally as a stabilizing element in stainless steel, in much the same manner as titanium. Susceptibility to intergranular corrosion is decreased in 18-8 grades and air hardening tendencies are lowered in 12 per cent chromium grades. This element is also a constituent of some of the high temperature alloys, developed for jet engines and the like, because it is effective in increasing creep strength. Additional uses are discouraged by the limited amount of ore available.

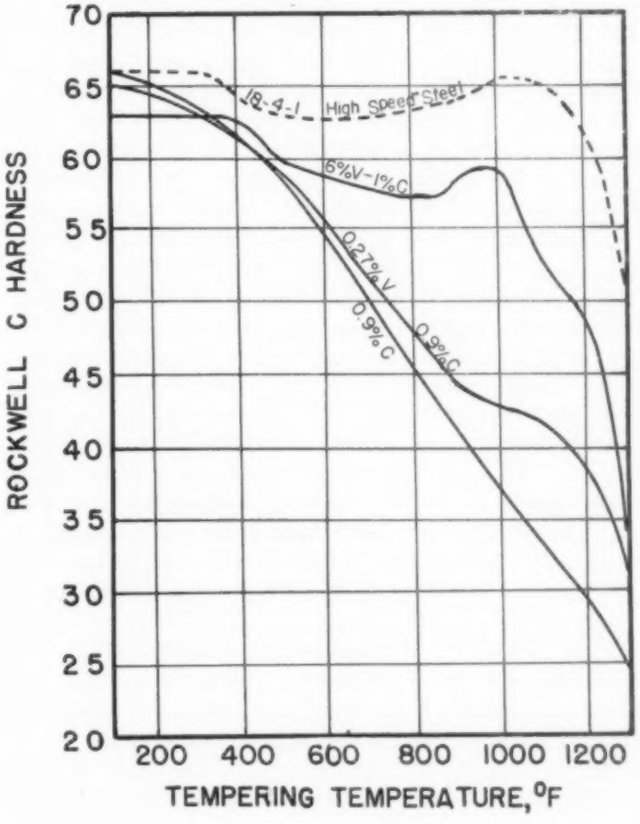
NEW DEVELOPMENTS

Having outlined the functions of the common alloys we propose to mention a few of the outstanding developments in the field of alloys, most of which are combinations of several elements. Several of these have already had a profound effect on alloy steelmaking and yet have not been fully explored. In other directions the development has been less spectacular, yet has resulted in a constant improvement in the type and effectiveness of alloys to accomplish definite objectives. When appraised in the light of the progress made in the last fifty years these developments appear highly significant.

Within the last few years a series of alloys were introduced which have truly remarkable effects on the mechanical properties of steels, particularly on their ability to be hardened by liquid quenching. The astounding part is the very small quantities of such an alloy necessary to produce this effect. The name generally agreed upon for them is "intensifier alloys." Most of these alloys are effective because of the small quantity of boron or the combination of boron with vanadium or titanium which is introduced into the steel by this means. The amount of boron added varies from 0.0005 per cent to 0.0030 per cent, which is of an entirely different order of magnitude than we have discussed in connection with the usual alloying elements.

The vanadium addition varies from 0.02 to 0.05 per cent and the titanium from 0.02 to 0.04 per cent in some of the combination alloys. Most of the intensifier alloys

Figure 7 — Effect of vanadium on tempering. (From, "The Alloying Elements in Steel," by E. C. Bain, A.S.M. Publication, 1939.



contain other elements in appreciable proportions, including vanadium, titanium, aluminum, silicon, zirconium, calcium, and manganese. Certain of these elements protect the boron by combining with the oxygen and nitrogen while others, particularly vanadium and titanium, are in large proportion dissolved in the steel and act as addition alloys. Thus, in some of the alloys boron is the only effective element added, while in others, there is one or more additional element responsible for the effect produced by the alloy. Generally speaking, the application of these alloys is limited to products of a size such that on liquid quenching nearly full hardening will result. The hardenability of steels treated with such an addition is approximately doubled, depending upon the composition and the original hardenability when measured by the usual test for this property. It is significant that there is an optimum addition of an alloy of this type, and that a greater addition does not result in greater benefits. One of the most remarkable points concerning these alloys is the fact that a comparatively small addition will impart similar hardening characteristics to those effected by much larger and therefore more costly additions of one of the more common alloys.

Most steelmakers are familiar with the new family of exothermic alloys which do not cool the molten metal, and even raises its temperature, when added to the furnace or ladle. Ever since steel has been made the addition of cold material to molten metal has been a problem, particularly final additions, since the soundness, cleanliness, and many other characteristics are directly dependent on the teeming temperature. A chromium alloy was the first one introduced and has been very successful for additions of chromium of 1 per cent or less. Dependable recovery of chromium as well as the absence of chilling of the metal is experienced. An exothermic silicon alloy is being used rather extensively for final additions of silicon to the ladle under circumstances where the use of ferro-silicon would cause an undesirable reduction in the temperature of the steel, or where an increase in temperature is desired either to compensate for other additions or to correct an inadvertently low tapping temperature. Other alloys of this nature are in the development stage.

There have been numerous developments in the group of alloys classified as deoxidizers. Combination alloys containing several of the elements, aluminum, silicon, manganese, titanium, and calcium have been found to be advantageous. More uniform distribution of the deoxidizing elements and a more dependable control of the grain size is claimed, as compared with the use of aluminum alone. In addition, less objectionable products of deoxidation are thought to be left in the steel. Gases other than oxygen, particularly nitrogen, can be controlled to some extent with these deoxidizers. The use of silicon carbide is becoming recognized as a deoxidizer for use in certain circumstances, including the control of rimming steel. Several of the very active metals, calcium and magnesium, which would reduce the oxygen content of steel to a much lower amount than aluminum, have been tried experimentally for deoxidization, but their vapor pressure is so great that a practical method of addition which will avoid the possibility of explosions has yet to be developed.

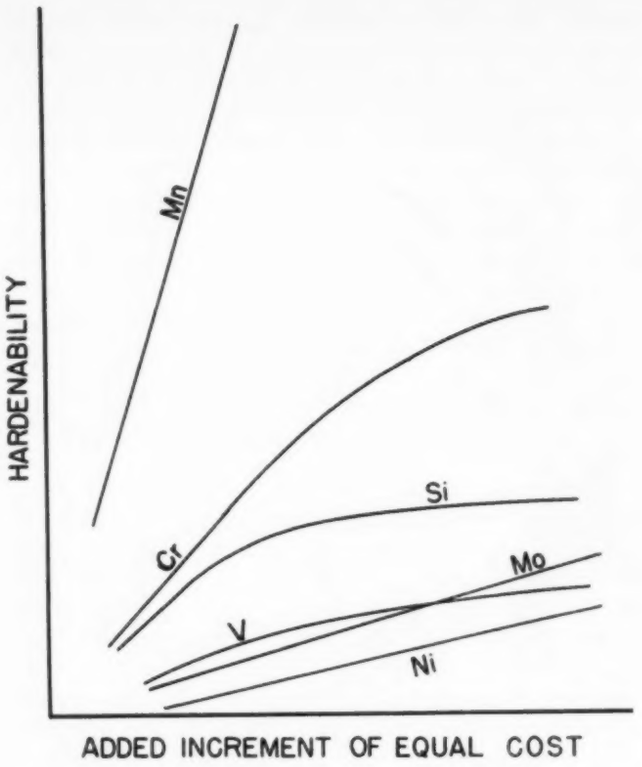


Figure 8 — Relative effects of equal cost increments of alloying elements on the hardenability of steel.

There are several combination alloys which have been tailor made to satisfy specific conditions. One example in the addition alloy classification is a chromium-silicon alloy developed for making a high-tonnage grade of steel containing both of these elements. The combination was found to be more convenient and more economical than the addition of the separate alloys. An example of a process alloy is also a chromium-silicon alloy used to reduce chromium from the slag of a heat of stainless steel, taking advantage of the additional chromium added at the same time without adding an appreciable amount of carbon.

The use of nickel oxide rather than electrolytic nickel for additions of this element to stainless steel is another novel development. This material is said to effect some reduction in carbon content when it is reduced in the molten steel. This practice is not yet very widespread.

Both chromium and manganese, as pure metals refined by electrolysis, are used to a limited extent in making steels which must be particularly low in certain impurities. Greater use of these materials probably depends on a lower price.

By way of summary, we have tried to describe briefly the functions of the common alloying elements used by the steelmaker. It has been pointed out that some of the alloys are used chiefly as an aid to the process itself while others are added to the finished or nearly finished steel to effect certain desired changes in its physical or mechanical properties. It is to be emphasized that while the actions of steelmaking alloys can be predicted broadly, specific results are so dependent on a number of factors that generalizations can be very misleading without an intimate knowledge of details.

DISCUSSION

PRESENTED BY

G. B. ROSS, Metallurgist, Republic Steel Corp., Buffalo, N. Y.

E. A. GIETZEN, Metallurgist, Bethlehem Steel Co., Lackawanna, N. Y.

J. H. JANSSEN, Assistant Chief Metallurgist, Wickwire Spencer Steel Div., Buffalo, N. Y.

T. W. MERRILL, Metallurgical Engineer, Vanadium Corp. of America, Bridgeville, Pa.

G. B. Ross: Mr. Merrill has illustrated the importance of alloys by tracing their historical development. They are important not only as additions to the final heat, but also as processing metals during the melting and refining period. Mr. Merrill also illustrated the cost of obtaining a given hardenability using various alloys. Manganese and chromium were the most economical. With current shortages or doubtful supplies of these two alloys, it is gratifying to note that a great deal is being done to develop others.

E. A. Gietzen: In the manufacture of low carbon sheet steel, where the alloy content is much less than shown on Figure 4, we agree quite well with the results of the author's page. However, there is one exception which we have found by experience. We agree with the phosphorus and the chromium in their respective positions, that is, the phosphorus having the greatest effect and the chromium least effect. Nickel is shown higher than molybdenum. We have found molybdenum on low carbon sheet steel has greater effect than the nickel and we would also add copper in the position between nickel and the molybdenum. We believe the order would be molybdenum then the copper and then the nickel.

J. H. Janssen: During the war we had to conserve alloys. We tried to add intensifier alloys and cut down our alloy additions. In a 15-ton acid electric furnace we poured ten ton with a straight intensifier addition. To the balance or 5 tons, we added 30 lb of boron bearing intensifier alloy. I am not sure what the boron content was, however, the heat finished:

Carbon	0.27 per cent
Manganese	0.95 per cent
Phosphorus	0.030 per cent
Sulphur	0.035 per cent
Silicon	0.34 per cent
Molybdenum	0.22 per cent

Heat treatment 1800 air-cooled — 1600 water-cooled — 1240 drawn

The Jominy test showed a difference of only 3 points Rockwell "C" hardness.

	Yield	Reduction of area
Intensifier alloy	91,000 psi	67 per cent
Boron bearing intensifier	87,500 psi	40 per cent

The object of this experiment was to determine if it were possible to obtain physical properties, after heat treatment, with boron comparable to the regular analysis then being used of:

Carbon	0.29/0.32
Manganese	1.00/1.10
Phosphorus	0.05 max
Sulphur	0.05 max
Silicon	0.25/0.50
Nickel	0.30/0.40
Chromium	0.25/0.35
Molybdenum	0.12/0.15

Yield	Tensile	Reduction of area
80,000 psi	120,000 psi	45 per cent

In the experimental heat we made the yield all right, but the reduction of area was low and we obtained no more hardness than when using our regular practice. We decided not to experiment with it anymore, but I would like to know if this is all the hardness that can be expected from the addition of boron.

T. W. Merrill: Three types of intensifier alloys are commonly used, the first two containing vanadium, and all three containing boron, although the third contains about three times as much as the other two, i.e., 0.50 per cent. Ordinarily the hardenability increase imparted by these alloys is greatest for the first and least for the third, although there is not a large difference between them. In adding any one of these alloys to acid electric furnace steel, there are two important precautions necessary to insure the desired results. First, the steel must be thoroughly deoxidized so that the addition will not be oxidized by the steel; the elements contained in these alloys, vanadium, titanium, aluminum, and boron, combine readily with any excessive oxygen present in the steel. An aluminum addition prior to the intensifier addition is desirable. Second, it is necessary that the furnace slag be held back during tapping so that virtually none covers the steel in the ladle when the addition is made, for this slag very easily oxidizes the intensified alloy. Needless to say, the more of the alloy that is oxidized, the less effective it will be in increasing the hardenability of the steel. Under the proper circumstances, approximately 90 per cent of the vanadium and 70 per cent of the titanium added as intensifier alloy are recovered.

As to the magnitude of the increase in hardenability imparted by the intensified alloys, it can be said that, in general, the depth of hardening on a Jominy specimen is at least doubled, as compared to the same steel without intensifier, depending to some extent on the base composition. Tensile properties will be increased accordingly, depending upon the size of the piece quenched and the tempering temperature used. In cast steel, however, it is necessary to adjust the deoxidation practice to avoid low ductility resulting from grain boundary inclusions. Such inclusions might possibly have caused the low ductility in the example cited by Mr. Janssen.

E. A. Gietzen: I would like to add something to the intensifier alloy comments. The addition of an intensifier to carbon steel ingots produced an increase in the Jominy hardenability. This increase was similar to that shown in Mr. Merrill's paper. The physical properties of quenched and drawn bars were very good as far as the tensile and yield point were concerned but the reduction and elongation were rather low.

T. W. Merrill: That is not characteristic; I might say that it is more often the other way around. By permitting more thorough hardening one will generally increase ductility, and that is usually found to be the case with grainal treated steel. If the steel is made and heat treated properly, the ductility should be proportionately a little higher than without an intensifier addition, but definitely not lower.

CENTRIFUGAL PURIFICATION OF OILS *in Steel Plants*

By CHARLES M. AMBLER
Process Engineer
The Sharples Corp.
Philadelphia, Pa.

. . . . the centrifuge is a particularly valuable tool for cleaning and rehabilitating oil when there is a difference in phase or density between the oil and the impurity . . . .

▲ THE selection of the proper lubricant for any type of service belongs in the field of the lubrication specialist. The most suitable lubricant may be an aqueous solution of soluble oil or "soda water" for a grinding job, it may be a highly refined mineral oil for turbine lubrication, or it may be a specially compounded grease for hypoid gear lubrication.

No matter what the lubricant is, or the type of service to which it is applied, its utility is reduced by the impurities it picks up under service conditions. Unless the same critical attention is given to the purification of the lubricant, as is given to its original selection, optimum results during its use will not be obtained.

It seems obvious that the contamination of the lubricant will be a function of its service conditions. The impurities in the used grinding compound will be particles of metal from the work, and abrasive and binder from the wheel. Moisture, from leaks, condensed steam and atmospheric "breathing," metallic particles and foundry sand loosened from the cast parts will be found in the used turbine oil. The hypoid gear grease will pick up metallic particles from the gear and housing.

A second source of contamination of the lubricant is the atmosphere in which it is being used. The used lubricant in a cement mill will always contain large amounts of cement dust. Iron oxide from the blast furnace and scaling operations and carbon from the coke plant will be found in a steel mill lubricant.

Another type of contamination is the breakdown products of the lubricant itself. Perhaps the most notable example of this is the deterioration of the oil in an internal combustion engine where, due to conditions of very high localized overheating, breakdown of a portion of the oil to carbon is evidenced by the darkening in color, is usually quickly noted.

As the oil is used, partial oxidation may result in the formation of sludge, of varying degrees of solubility, with its tendency to coat the surfaces of oil coolers, interfere with heat transfer and even clog small transfer lines. The sludging of oils is frequently accelerated or catalyzed by the presence of metallic particles, making their removal doubly important.

It may be said that the primary functions of a lubricant are:

1. To provide a smooth, uniform surface, often of submicroscopic thickness, on which moving parts may roll or slide with a minimum of friction.
2. To carry away or distribute the heat of friction.

Both of these functions are impaired by the presence of extraneous matter in the oil.

While the list of impurities given above represents a large degree of over simplification, it is interesting to note that most of the impurities are discrete particles, or in the case of moisture, separate phases, which have significantly different densities from that of the lubricant itself. Such impurities are peculiarly well suited for removal by gravity or centrifugal subsidence.

Centrifugal force is that force which tends to impel a thing, or its parts, outward from a center of rotation. The amount of this force is proportional to the distance

Figure 1 — In the conventional gravity trough the heavier solids settled out first at the incoming end of the trough.

Presented before AISE Annual Convention, Cleveland, Ohio, September 30, 1948

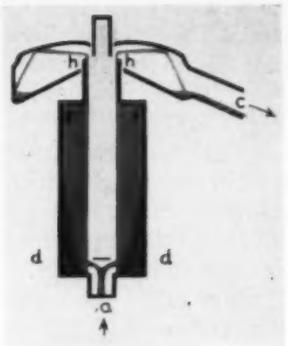


Figure 2 — A centrifuge can be considered to be a sedimentation basin turned on end with centrifugal force substituted for gravity.

of the thing from the center of rotation and to the square of the speed of rotation.

Centrifugal force differs only from the force of gravity in that

1. It may be many times greater than the force of gravity.
2. It is applied in all directions from a center, instead of in one direction as gravity. The lines of force of centrifugal force diverge or radiate from a center, those of gravity are almost parallel, converging toward the center of the earth.

While centrifugal force should be expressed in force units of dynes or pounds, for comparative purposes it is more conveniently referred to as a multiple of the gravitational constant, and may be calculated from the formula:

$CF = 1.42 \times 10^{-5}\ Dn^2$, in which
CF = Centrifugal Force
D = Diameter in in.
n = rpm.

When the particles to be removed are relatively large, the limit to the rate at which they can be settled is the turbulent resistance of the liquid to motion through it. With smaller particles the settling rate is a function of the viscous resistance of the liquid to passage through it. In almost all cases, therefore, the viscosity of the liquid has an important bearing on the degree of purification obtained, and purification is substantially assisted by operation at elevated temperatures where the viscosity of the liquid is minimized.

Most centrifugal phenomena can be understood and illustrated readily by figures employing gravity.

CLARIFICATION

A conventional gravity trough is illustrated in Figure 1. Liquid is poured into the trough at "a." The trough fills until point "h" is reached, where it overflows into the funnel and discharges at "c." Any solids in the liquid will settle to the bottom of the trough, the heaviest depositing first at "d," the lighter settling more slowly and depositing nearer "f," being carried forward by the flow of liquid through the trough.

The length of time the liquid is subjected to the separating force of gravity depends on the holding capacity of the trough and the rate of flow.

The sketch shown may be made to illustrate a cross section of a centrifuge clarifier bowl by turning it around and supplying a corresponding other half (since bowls are circular). See Figure 2.

Here the liquid is jetted in at "a" and is thrown by centrifugal force against the walls of the bowl. The bowl fills until point "h" is reached (the discharge holes), and liquid then discharges into the cover, flowing from the cover spout "c." Heavy solids deposit near the point of first contact "d," and lighter solids farther up in the bowl.

SEPARATION

Another type of gravity trough is illustrated in Figure 3. If water is fed in at "a," this trough will fill up until "h" is reached, and the water will then overflow, discharging at "c" and with solids settling out, as was illustrated in Figures 1 and 2.

If after the trough is full of water up to the level "h" (and it can, of course, be filled no farther), the feed of water is stopped and oil is poured in at "a," the baffle "lx" will prevent such oil from discharging. If "e" represents the surface of the water, oil will begin to build up above that point toward "l" (see Figure 4). The weight of the oil on the upstream side of the baffle will displace some water at "h" until the weight of liquid on both sides of the baffle is equal. This displacement of water moves the "e" line toward "x." If oil continues to flow into the trough, the level of oil will continue to rise and the "e" line will continue to move toward "x" until the oil level reaches "l" (the top of the baffle). After this point is reached, any more oil poured into the trough will displace an equal amount of oil at "l," which will overflow and discharge at "k." Since incoming oil is now displacing an equal amount of oil already in the trough, further feeding will not increase the weight of oil in the trough, so there will be no further depression on the "e" line.

Any water that is fed will drop through the oil by

Figure 3 — The gravity trough can be modified by the use of a baffle to separate out anything which may float on the surface.

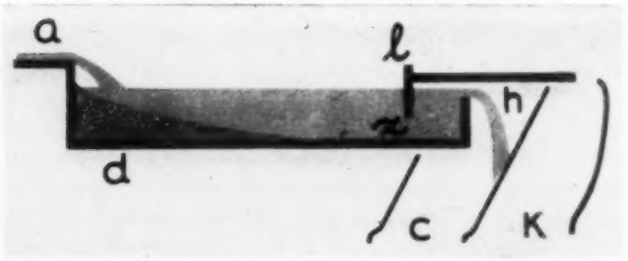
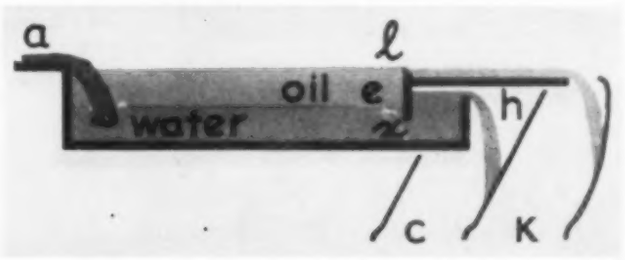


Figure 4 — In this figure the gravity trough of figure 3 is used to separate oil from water.



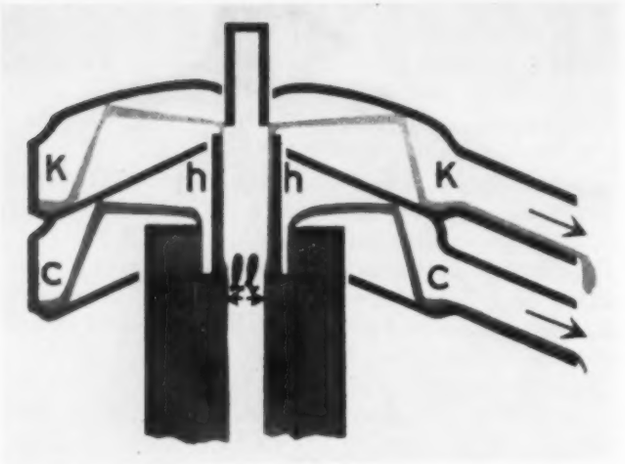


Figure 5 — By turning the gravity trough of Figure 4 on end, the result is essentially a centrifuge separator.

gravity and displace an equal amount of water at "h." Mixtures of oil and water fed to the trough separated by gravity will displace their respective volumes of like material, causing separate discharge of oil and water at "l" and "h."

Turning Figure 4 on end and supplying another half creates a cross section of a centrifuge separator bowl. See Figure 5. The "lx" disc is a circular disc attached to the inside of the bowl top, with a hole in the center. Light liquid flows over the center at "l" and into the covers through discharge holes, heavy liquid discharges at "h," and the diversion between the two liquids is at "e." Any solids will separate and deposit in the bowl just as in a clarifier.

DAM ADJUSTMENT

Referring again to the gravity trough of Figure 4, if the oil is very heavy, almost as heavy as water, then because of its weight, it will displace almost an equal volume of water, when poured into the trough, with the result that the "e" line may be depressed as far as "x" before the surface of the liquid reaches "l." See Figure 6.

If any more oil is added it will lower the "e" line still farther, allowing oil to escape around the bottom of the baffle at "x" and discharging at "h." Under these conditions both oil and water will discharge together and no oil can ever discharge at "l." The remedy for this condition is to raise the end of the trough "h" to so nearly the same height as "l" that the oil surface may reach "l" before it depresses the "e" line as far as "x."

Figure 6 — When the two materials which are to be separated from each other have almost the same specific gravity, the "e" line will be depressed quite far before separation flow goes over the baffle.

Conversely, if the oil is very light, it may discharge at "l" with only a slight depression of the "e" line. This condition may also be undesirable. If the light liquid is the one that is to be recovered and the heavy liquid is waste, it is best to have as deep a layer of the light liquid as possible for two reasons: First the deeper layer means a greater quantity of the oil in the trough, which means a greater time under the influence of gravity for a given rate of flow, and secondly, in a mixture such as oil and water there may be a certain amount of unresolved emulsion at the "e" line, which might discharge with the light liquid if the "e" were close to "l." Since the heavy is waste, there is no objection to a discharge of this emulsion at "h" provided too much of the light liquid is not lost in this way.

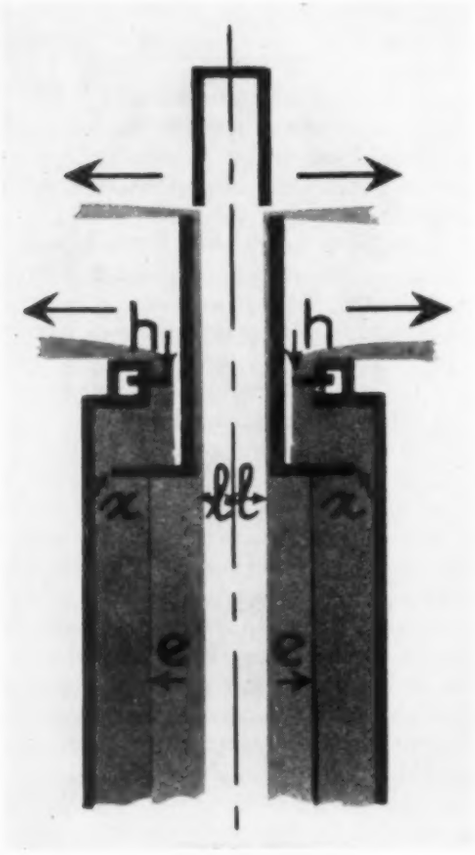


Figure 7 — Rings of various diameters are used in the centrifuge to separate materials with various specific gravities.

To get "e" close to "x" and thus obtain the desirable deep layer, when a light oil is treated, it is necessary to lower "h" so that only a shallow depth of water needs to be balanced by the weight of oil.

In Figure 7 the gravity trough is again converted into bowl construction. This figure is the same as Figure 5, except that "h," instead of being a fixed point is a removable ring with a hole through the center over the edge of which liquid flows. Rings of different inside diameter may be used, thus raising or lowering the "h" line. By using the proper size ring (called ring dam) the "e" line can be located at the desired point. If the light

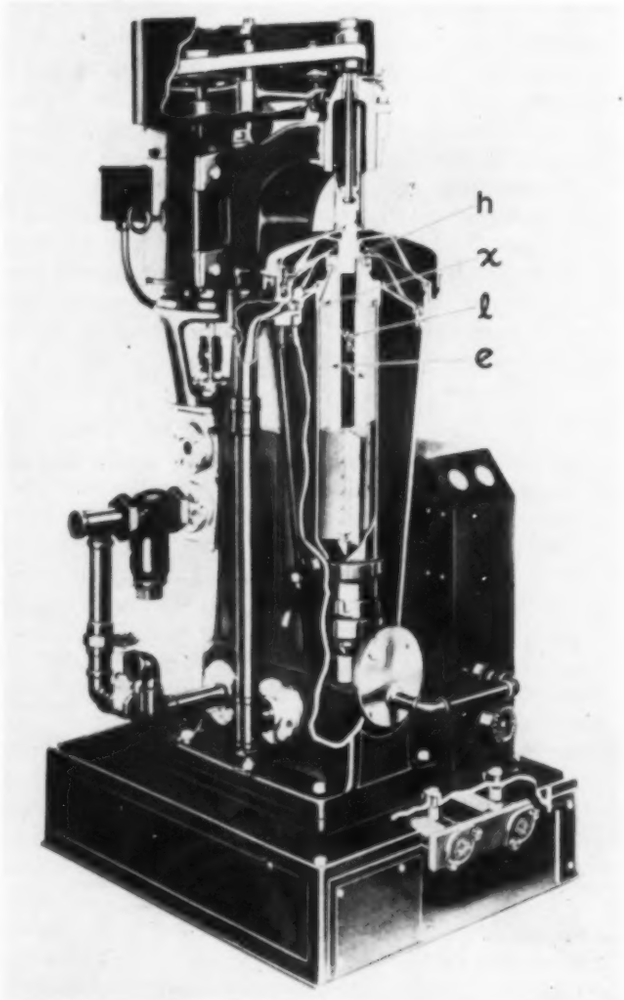
liquid is the one to be recovered, the "h" should be so dimensioned that the "e" will be as near "x" as possible without losing an appreciable amount of the light liquid with the heavy discharge. If the heavy liquid is the valuable effluent, the "e" should be as near the "l" as possible.

A centrifuge employing these principles is shown in Figure 8. It consists of a rotor or bowl incorporating the principles discussed above, driven from above by an electric motor, and mounted in a frame or housing. The frame serves to minimize power losses from windage and maintain the various parts in correct alignment. The feed is jetted into the bottom of the bowl through a feed nozzle. The separated liquids discharged from the bowl are caught in covers surrounding the top of the bowl, from which they flow out by gravity.

A high capacity super-centrifuge, of a type frequently used for steel mill oil purification, is shown in Figure 9. In this design the housing also serves as part of the covers and more space is provided for the flow of viscous oil at relatively high rates.

A simple oil purification system incorporating such a centrifuge is shown in Figure 10. The tank receives used oil from the lubricating system. Oil is drawn from the bottom of this tank, where its impurities are at their maximum as a result of gravity settling in the tank, pumped through a heater and then to the centrifuge. Any separated water is run to waste and the purified oil is pumped back to the tank.

Figure 8 — The centrifuge consists of a rotor driven by an electric motor. The material to be clarified is introduced through a feed nozzle and the separated liquids flow by gravity over the top of the bowl.



In such a system it is customary for the tank to have two compartments or sides, separated by at least a partial baffle. Used oil from the main lubrication system is run to the dirty side of the tank from which it overflows to the clean side. The suction for the main lubricating pump is taken from the clean side so that all oil returned to the main system has been partially purified by gravity settling in the tank. The suction for the centrifugal purification system is taken from a low point in the dirty oil side of the tank, where impurities are at their highest concentration as the result of gravity settling in the tank. The dirty oil is run through a thermostatically controlled heater, in which it is heated to the optimum point for centrifuging. The particular heater illustrated uses steam as the heating medium. This heater may alternatively be heated electrically or by hot exhaust gas.

Since the system shown requires separate feed and discharge pumps, an interlock is provided to eliminate the possibility of flooding on the discharge side. The dirty oil feed is through a valve controlled from a float in a small sump interposed between the clean oil discharge side of the centrifuge and the clean oil pump. Any failure of the latter will cause oil to back up in the sump, raise the float and cut off the feed to the centrifuge.

A priming funnel is installed in the feed through which water can be added to the centrifuge bowl at the start of a run to seal off the "x" dimension.

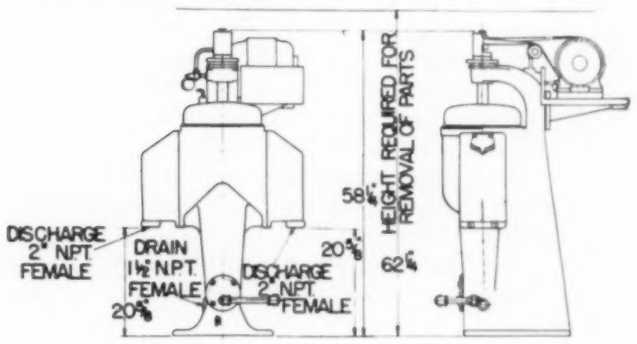
The purified oil discharged from the centrifuge is returned to the clean oil side of the tank where it is made immediately available for return to the main lubrication system. Any necessary make up oil is also added at this point.

It will be noted that the main flow of lubricating oil in such a system is independent of the centrifugal purifier system and that the centrifuge on such a by-pass system need only be run as required to maintain the oil in the main system at the desired degree of purity.

Centrifuges are available to handle from 50 to 600 gallons per hour of oil on such a system depending on their size, the viscosity of the oil, the kind of impurities present, and the degree of purification required.

In cases where relatively small quantities of oil exist

Figure 9 — A typical centrifuge for steel mill use is sketched in this photograph.



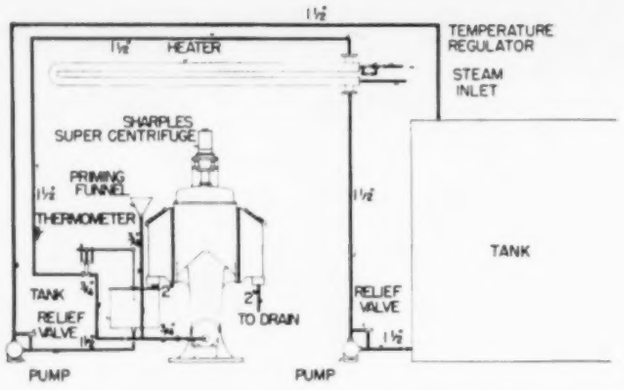
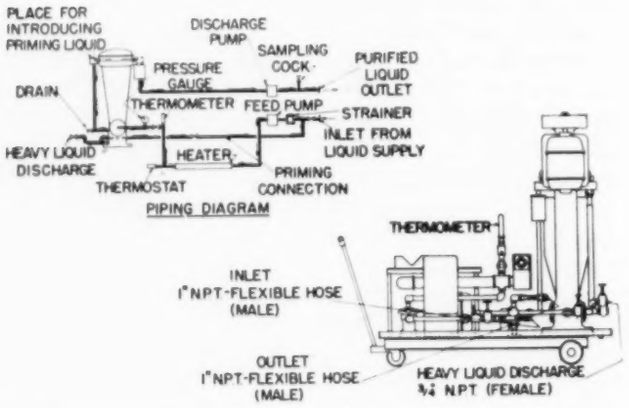


Figure 10 — The oil purification system illustrated uses a centrifuge to clarify the oil.

Figure 11 — If the centrifuge is mounted as a portable unit, it can be used at locations where it would not be economical to mount a permanent unit.



in separate lubricating systems and a common oil system is not practical, the centrifuge pumps and heater may be mounted as a portable unit and transported to the individual jobs. Such a unit is shown in Figure 11.

After the unit has been wheeled into place and connected electrically, the flexible inlet hose is dropped to the bottom of the oil sump and the purified oil returned to a point in the system where it will flush any accumulated impurities in the system back to the sump. Operation is continued until the contents of the system are at a satisfactory state of purity and the unit is then wheeled to the next job.

For machine tool work, or where the utmost in purification of the oil is required, such a unit may be equipped with a tank large enough to hold the batch of oil in the system. The oil is transferred from the sump through the centrifuge into the tank, the sump wiped out or otherwise cleaned and the oil centrifuged again while passing from the tank into the sump.

Centrifuges, or combination units, such as these described are used for the purification of lubricating oils, quenching oils, hydraulic system oils and cutting oils. In every case, the discharge of the separated water is continuous and high water overloads may be handled without difficulty. Many examples can be cited where lubricating systems have been kept in satisfactory operation until normal shut-down time in spite of really bad seal failures.

Somewhat more elaborate oil purification systems than those described above may be installed in cases where continuous heavy duty service is required. Such a system is shown in Figure 12. It will be noted that 100 per cent standby is provided for all equipment in the main circulating line.

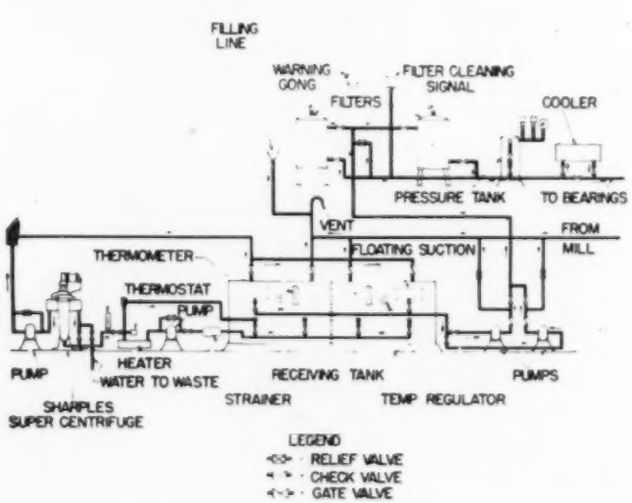
This system would normally be installed below the mill floor level so that the used oil from the bearings will run by gravity to the operating receiving tank. These receiving tanks are equipped with thermostatically controlled heating coils, indicating thermometers and level indicators, and floating suction lines through which the cleanest oil from the surface of the tank may be drawn for return to the roll neck bearings. This circulating oil is passed through filter screens to remove any relatively coarse abrasive particles that may not have settled out in the receiving tank, and through a cooler to reduce the oil to the proper temperature for satisfactory lubrication of the bearings.

The use of a floating suction in the receiving tank provides full oil flow to the return system even with relatively large variations in the amount of oil in the system (and in the oil level in the tank).

The oil to be centrifuged is drawn from the bottom of the tank where its concentration of water and other impurities are highest, centrifuged as described above, and the centrifugally purified oil flow is returned to the surface of the receiving tank adjacent to the floating suction inlet.

It will be noted that the full oil flow passes through the receiving tank, where it receives a degree of purification from gravity settling, and through the filter screen where the relatively coarse, harmful abrasives are removed. The centrifuge receives oil at the highest concentration of impurities obtainable by gravity settling in the receiving tank. The centrifuge removes these impurities and discards them from the system without loss of oil. It returns the purified oil back into the system. The function of the centrifuge in a system of this type is to remove the impurities, for discard from the system with minimum oil loss, and by removing them to keep the impurity concentration in the entire lubrication system at the lowest possible level.

Figure 12 — The oil clarification system shown was designed for heavy duty service.



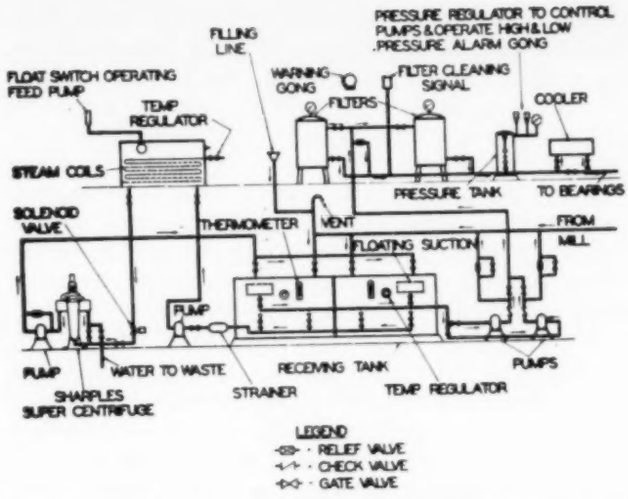


Figure 13 — If the feed to the oil purification system can be accomplished through gravity, better cleaning action will result.

In some instances water in the oil from the mill will be in a highly emulsified form.

Such emulsions may frequently be broken more easily and completely if the emulsion, after being heated to operating temperature, is held or "rested" for a period of time.

When emulsions are held at elevated temperatures, where the viscosity of the oil is as low as practical, coalescence of the dispersed water particles takes place and the centrifuge has less work to do because it is working on larger particles. It has further been found in many cases that better centrifugal separation, in terms of throughput rate and purity of the separated products, is obtained when the centrifuge is fed by gravity instead of by pump. Pump action on many highly stabilized emulsions increases the amount of work the centrifuge has to do and should be avoided when possible.

Figure 13 shows a complete oil purification system of this type. The only additional control that is introduced is a float switch on the feed tank to provide a high level shutoff of the transfer pump from the receiving tank.

In many steel mills there is a large inventory of insulating oil in service in switches and transformers. Under operating conditions such oils become contaminated with moisture, dust, sludge and, in the case of the switch oil operated under arcing conditions, carbon. These impurities lower the dielectric value of the oil, raise its power factor, and in extreme cases coat out on the metal surfaces and interfere with proper cooling of the switch or transformers. In many cases such insulating oils may be restored to their original dielectric value by a single pass through a centrifuge. In others, it will be found advantageous to pass the oil through a blotter filter press to remove every trace of moisture and fine colloidal carbon. A self-contained purifier mounted on a portable truck is illustrated in Figure 14. In this application, as in many others, it is easier to carry the tool to the work. The unit is wheeled into position, the electrical connections made and the inlet hose attached to the drain outlet or other low point of the switch or transformer. The oil is picked up by the built-in pump, passed through the thermostatically controlled heater and into the centrifuge. When large quantities of water are present, the centrifuge is operated as a separator, under more normal conditions, it is operated as a clarifier and all impurities, including moisture are held in the rotor.

The purified oil passes into a receiving tank in which there is a float control to a valve on the centrifuge feed line. From here a second pump passes the oil through the filter press for return to the transformer. Circulation is continued until the oil feed to the centrifuge has the desired electrical characteristics, indicating that not only has the oil been purified but that the entire transformer has been swept out with purified oil. Complete units of this type are available to handle up to 1200 gallons per hour and raise the breakdown from 6 kv to 30 kv in a single pass at 120 F.

Many steel plants are finding interesting economies from the recovery of palm oil from cold rolling mill operation. Not only is a thoroughly nasty and frequently expensive disposal problem eliminated, but a product is obtained of value for sale to soap manufacturers or even, in some cases, for reuse in the mill. The

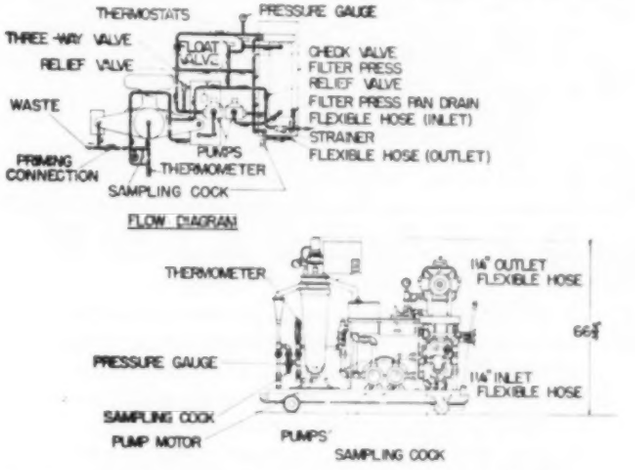
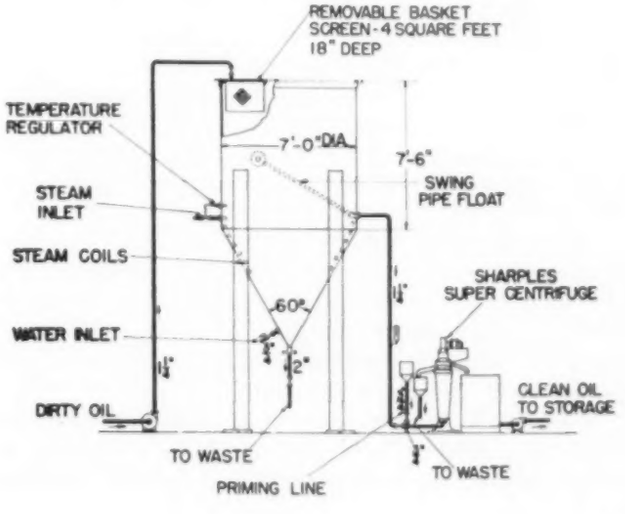


Figure 14 — The portable unit shown is of particular value in cleaning switch or transformer oils.

Figure 15 — The centrifuge has also been used to clean palm oil, and the product can in some cases be used again in the mill.



under flow stream from the cold mill is run through a skimming basin on its way to the sewer. The palm oil collects as sludge almost quantitatively on the surface of the basin and is periodically transferred by diaphragm pump to the tank shown in Figure 15. The coarse mesh strainer shown removed large trash such as gloves, etc. After a tankful of sludge has been collected, heat is applied. When such a tank of palm oil sludge is held at elevated temperature for a period of time a partial separation takes place, impure oil floating to the surface, while the bulk of the water and solid impurities settle to the bottom of the tank. The higher the temperature, the quicker and more completely this primary separation takes place and the use of enclosed tanks in which the rendering operation can be conducted under pressure has been found to be advantageous.

In an operating plant two such tanks are used. While one is being filled the other is being rendered and after the water and heavy solids have been drawn off through the bottom, the supernatent oil is passed to the centrifuge through a floating suction line for final purification.

A complete plant would also include transfer pumps and a large tank for accumulating the clarified palm oil prior to bulk shipment.

Centrifuging has been proven over the years to be one of the most versatile and reliable means for the purification of oils. Being entirely mechanical in its action, only the impurities are removed. The basic character of the lubricant, including its additives remains unchanged. It is quick, reliable and economical.

DISCUSSION

PRESENTED BY

R. J. GRAHAM, Assistant Supt. Steam and Combustion Dept., Bethlehem Steel Corp., Johnstown, Pa.

C. E. PRITCHARD, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

FRANK RAFFELL, Millwright Foreman, Hot Strip Finish Dept., Republic Steel Corp., Cleveland, Ohio

WILLIAM A. SMILEY, Electrical Engineer, Bethlehem Steel Co., Steelton, Pa.

ANDREW CICHELLI, Lubricating Engineer, Bethlehem Steel Co., Sparrows Point, Baltimore, Md.

CHARLES M. AMBLER, Process Engineer, The Sharples Corp., Philadelphia, Pa.

Russell Graham: The value of the centrifuge in lubrication has been well demonstrated, we all must agree, particularly in clarifying low viscosity oils which are subject to considerable water contamination in circulating systems. The water can come from cooling water sources, or in the case of steam-driven units, from leaking packing gland condensation.

In the use of a centrifuge as a part of an oil clarification system or as the one method of purification, it is well to install the centrifuge so that it can be bypassed, as Mr. Ambler mentioned. This is because the centrifuge will require maintenance and, in many cases, you do not want to run it all the time.

I would like to emphasize the value of the portable centrifuge. We have several of these units mounted on hand trucks, as described, complete with integral pumps, and flexible suction and discharge lines. These portable units have proven invaluable throughout our plant, especialy in our power stations.

In one case during the middle of the week, it was discovered that the 300 second oil in a herringbone gear set had become contaminated with 37 per cent water. The shutting down of this unit would have affected 20 per cent of our plant's operation. A portable centrifuge was taken to the unit and run continually until the weekend, when the plant operating schedule permitted repair.

The design of a lubricating system in a steel plant is getting more attention, which we all agree it deserves. It was common years ago to locate a receiving oil tank with pumps and clarification units, if any, in some dark corner or down in some out-of-the way place in the cellar where it received little care. Mr. Ambler stated, and I am quoting him, "Unless the same critical attention is given to the purification of the lubricant as was given to its original selection, optimum results will not be obtained."

Too often, over-emphasis is placed on the choice of a particular brand of oil for a lubricating system and under-emphasis on how the oil is to be maintained.

Charles E. Pritchard: Mr. Ambler delivered a very excellent paper, so much so that it introduces the thought in mind that possibly there has been too little explanation given regarding the proper selection of ring dam size to the actual operator in the field who is supposedly responsible for getting the most efficient yield out of the oil in question.

I assume that the ring dam size is determined on a pre-calculated gravity differential basis, but I, for one, have not seen any chart or instruction manual that is supposed to be given to the man who is to do the job in the field. All too often, the man gets the centrifuge and will start the unit up on a given oil without knowing whether or not he can expect satisfactory service therefrom without a long drawn out trial and error experimentation. This is especially true where the unit is of the portable type.

Mention was also made regarding heating of the water and oil emulsion to an optimum point prior to centrifuging. I would be interested in hearing Mr. Ambler's comments on how this optimum point is derived.

I would also be quite interested in learning what the line of demarcation is between the usage of a centrifuge for clarification and dehydration. I assume that it is possible to express this in terms of moisture content. The question has repeatedly come up from time to time as to just where dehydration stops and clarification begins.

Frank Raffell: Since it is impossible to crawl inside a centrifuge while it is in operation, Mr. Ambler's paper leaves no doubt in my mind as to what does happen inside the centrifuge. However, what happens on the outside is the other part of the story. Of what value is the machine in a mill set-up—does the machine pay off?

On a large rolling mill, centrifuges can be classed as another insurance against costly delays or shut downs. As Mr. Ambler stated, "lubricating systems have been kept in satisfactory operation until normal shut down time."

Let me cite an instance that happened in our hot mill

this past May. We started up our backup system on Monday the 24th with a good tank of oil, of approximately 10,000 gal. On the day turn Tuesday, it was discovered after making a test, that we had a 1.5 per cent water content. On Wednesday the reading was 1.8 per cent. This was still not bad but the operators began moving just a little faster trying to find where the water was coming into the system. The following midnight turn the oil was rapidly discoloring and a test showed that we had a 3.1 per cent content which was getting worse because a seal at No. 4 mill had failed. The operator immediately started up No. 1 centrifuge. On the Thursday day turn, the reading was 4.5 per cent, still rising, so a second machine was started. The 3-11 o'clock turn hit the top limit of 5 per cent, so the third machine was started. With three machines in operation, the situation was under control. At eight hour intervals after starting the third machine, the readings were 4.1, 3.4, 2.7 and 2.1 per cent when the mill was shut down. With the mill down, the reading was $\frac{1}{10}$ of 1 per cent after eight hours. The machines were shut down and cleaned one at a time. In this instance, about five rolling turns and nearly 10,000 tons of steel were saved. We have a standby tank but, to have switched tanks with a condition such as the one mentioned would have only given us one turn at the most instead of finishing out the rolling schedule for the week.

A third factor and a second part of the outside story is the operator. Selection of the right person and proper training goes a long way in just how efficiently a system works.

A good operator knows his mill, his oil systems, the condition of the oils. His equipment will be clean and in good condition. He will be especially proud of his cleaning equipment because it is the heart of the lubricating system and it is ready to start at a moments notice. He will know what to do and when to do it.

Cleaning, inspecting and making the necessary repairs to a centrifuge after a run is very important. The centrifuge is a precision built machine that is perfectly balanced. A sledge hammer and 36 in. pipe wrench type of man is not the man for that job. The tools that are furnished with the machine do a very nice job when handled properly. Maintenance cost is very low if the machines are used with care.

I suggest that if the information and the illustrations presented by Mr. Ambler could be distributed in pamphlet form to operators of centrifuges, the information would be very helpful to them. I might suggest further that more specific instructions on the operation of centrifuges should be supplied with the machine. Selection of the proper sized dam for a certain viscosity oil is most puzzling—perhaps a table could be made up on dam sizes for the various oils.

A set of dams is furnished with the machine, but the question is, "which one shall I use?" Other questions that come up are, "how hot should the oil be heated," "how fast should the oil be fed," "when must the centrifuge be stopped and cleaned?"

William A. Smiley: In the treatment of insulating oils, you speak of breaking an emulsion. You also speak of dehydrating an oil. The dielectric strength of an insulating oil depends a great deal on the water which is dissolved in the oil. Does the centrifuge remove that water?

Member: It is possible to get the moisture out of the transformer oils if you have that trouble, but the trouble is to get the acidity out, since if you have a small amount of acidity in the transformer oil, it is not too good, and there is a limit to which you can go.

That can be eliminated by fuller's earth filters, but I have heard various opinions as to whether that oil can be used safely again or not. I would like to know if Mr. Ambler or some of the men present have this information.

There is one concern I know of that is using transformer oil filter repeatedly after it is drawn through a fuller's earth filter to remove the acidity. That company has been doing it for a long time, using the oil over and over. However, some of the large electrical concerns will tell you that it is useless to use that oil again, because once the acidity is broken down, the acidity will return in a short time again and you will have the same trouble. In other words, they recommend that if this oil reaches an acidity which prevents use, you have to throw it away or use it in some other way and take a refill of oil.

I would like to know if anyone has information on this subject. I have several thousand gallons of acid oil on hand and I am vitally interested.

Andrew Cichelli: There is a slight controversy as to the relative merits of the type centrifuge described and the one with a series of cones. I should like to have Mr. Ambler say something about that if he will.

You mentioned in your paper, I believe, that gravity feed was preferred to forced feed from pumps. I wish you would amplify upon that, please.

Charles M. Ambler: If you will forgive the liberty, I would like to take these questions up not in the order that they were asked, as I think the questions regarding insulating oil can be answered, if not satisfactorily, at least quickly.

A centrifuge will not remove soluble moisture from any oil or anything else. A centrifuge is a purely mechanical device that can only work when there is a difference in phase and density. However, there is a certain amount of residual moisture, both soluble and insoluble, evaporated from the discharge from that centrifuge which is not due to work done within the rotor itself.

We have done quite a bit of work on the circulation of oil from transformers repeatedly through the same centrifuge to learn something about the accumulation of acidity as a result of possible oxidation in the covers. Over relatively long periods of test, we have been able to find no effect, although theoretically it should be there. Practically, I would say the amount of oxidation is below any measurable amount.

The third question that was brought up was, "when transformer oil becomes badly acidified and sludged, can it be reclaimed?" By either a clay treatment or a combination of chemical and clay treatment, a badly sludged insulating oil can be restored to all of its original values except for life test. As far as we ever found out, the life went out of the oil. So, even though it had been reclaimed to original specifications, it would not stand up under service conditions.

Mr. Graham and Mr. Raffell did a good job of pointing out the value of centrifuges in a steel mill. I would

like to emphasize one thing again. A centrifuge is a tool; and should be used as a tool. It is not a cure-all. It will not keep the mill going when it is in really bad shape, but it is a tool of great value when properly used.

Mr. Pritchard asked for some information on the subject of the temperature. From the standpoint of centrifugal purification, the higher the temperature the better the oil will be purified.

Against that, we have to consider the fact that the oil will not tolerate a high temperature in itself. The temperature of centrifuging must be a compromise between possible degredation of the oil and the results to be obtained from centrifuging. On that basis I would like to see oil handled at 180-190 F. I think they represent rather ideal operating temperatures. Most oils are not damaged by heating to that extent, and centrifugal purification is greatly assisted.

The question has also been brought up on the proper selection of ring dam sizes. These can be determined from the formula

$$E = \frac{e^2 - l^2}{e^2 - h^2}$$

Nomenclature is given in Figure 7. In this formula, which is mathematically correct, large "E" represents the ratio of the specific gravity of the heavy phase to that of the light phase. "e" is the interfacial line as measured from the center, "l" is the discharge radius of the light phase, and "h" is the ring dam size.

Now, that tells us where the "e" line is, but it does not tell where we want it, and that is why the formula is not broadcast more widely. In any given type of service you have the condition that one phase is more difficult to separate than the other phase. Therefore, you want to set the line of division to favor that kind of separation. If the oil is the difficult phase to purify, then you want the "e" as near the "x" as possible.

The best that can be done with this formula is to say it tells the approximate ring dam size. If the values are in sixty-fourths of an inch, measured from the center of rotation, then on our machine "h" comes out to a value in sixty-fourths from which we deduct 20 to get the proper size number of ring dam. The indication would be that the No. 34 ring would be selected for this particular job.

It should be borne in mind that the large "E" must be figured from the density of the oil and the water phases at the operating temperature. That is not the handbook value but the actual value at operating temperature.

Having arrived at this figure, we then have a proper starting point for the selection of ring dam size. Suppose that the operator has just started off with a No. 34 ring dam and starts losing oil in the water. It means that he miscalculated where the "E" line should be for that particular job, and he should start going smaller on the ring dam size.

Conversely, if he starts up that way, and the oil contains some water, that means he can go out one or two notches on the ring dam size. So the formula gives you a chance to select the median ring dam size from which you can experiment on either size to find the optimum value for the particular job.

The third question that Mr. Pritchard raised was the subject of clarification versus dehydration. During the war a great number of centrifuges were sold to the Navy on Navy specification. That demanded that the centrifuge be able to run as a separator for a period of time, even though there be no water in the incoming feed. That was more or less a test condition because Navy oil very seldom stays dry for any period of time, but I think as a rough valuation, if the moisture content of the feed to the centrifuge drops below two-tenths of one per cent, then you should set the centrifuge up to run as a clarifier.

If the moisture exceeds three-tenths of one per cent, then the machine should be operating continuously as a separator.

C. E. Pritchard: We have not been able to sustain 180 to 190 F in difficult emulsion cases without facing a problem from the standpoint of having the oil-water emulsion boiling out of the tank with a decided loss of oil.

Charles M. Ambler: I think the only answer there is the old compromise that you run as hot as you can.

C. E. Pritchard: Getting back to the selection of the ring dam size, I think it is a little difficult for us to go out and try to train a man on the basis of the proper selection with the information as given. It is believed personally that there is a need for more detailed information before actually trying to train the man to whom you are allocating the responsibility of doing the job of centrifuging oils most efficiently.

Charles M. Ambler: I can only agree with that, and yet that selection of ring dam is sufficiently complicated mathematically so that you cannot expect an operator to solve the problem.

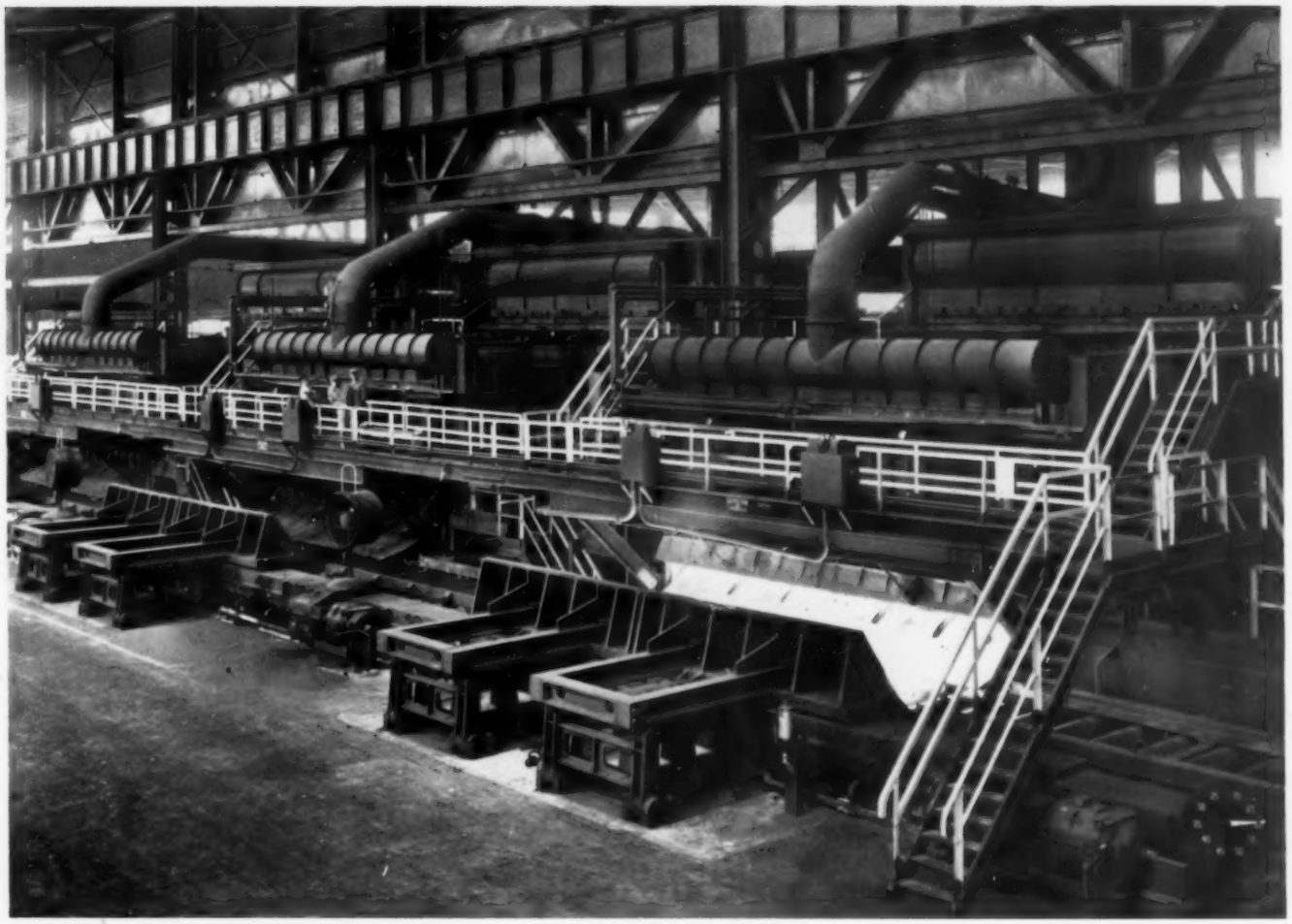
C. E. Pritchard: The practical aspects of setting up a program covering the centrifuging of oils on the other hand demands a given knowledge on the part of the operator as to just what range of ring dam sizes will suffice for the various oils he wishes to either clarify or dehydrate. How then can he be held responsible for doing an efficient job unless this information has been forthcoming?

Charles M. Ambler: I think it can only be said that the selection of ring dam size is something beyond the scope of the operator except on a trial and error basis.

C. E. Pritchard: On this basis we may logically expect a definite loss of oil with the ultimate being more of a compromise setting rather than a specific procedure to follow.

Charles M. Ambler: Right. In other words, the only thing we can tell the operator to do is if he starts up with a given ring dam and encounters a loss of oil in the water phase, he should immediately change to a size smaller and continually change to successively smaller size ring dams until he stops his loss of oil.

Going back to another question, the subject of cones is a tough subject to put into the discussion at this time. The company that I work for makes both types of centrifuges. We recognize the relative utility of both of those types, and we are in a position to offer what we feel is the best type for any particular service. In the case of oil mill-steel mill lubrication, we feel that beyond question the tubular type of bowl is the best one for the service conditions involved.



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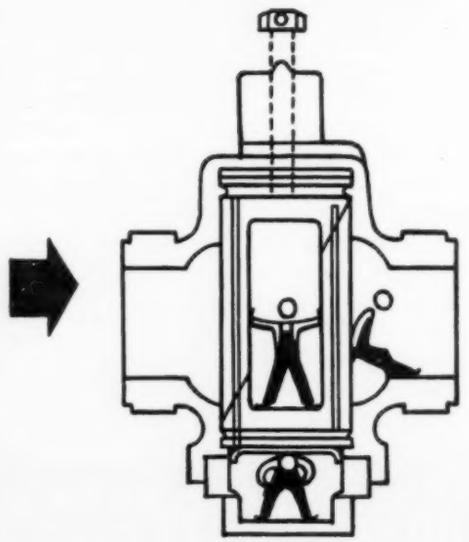

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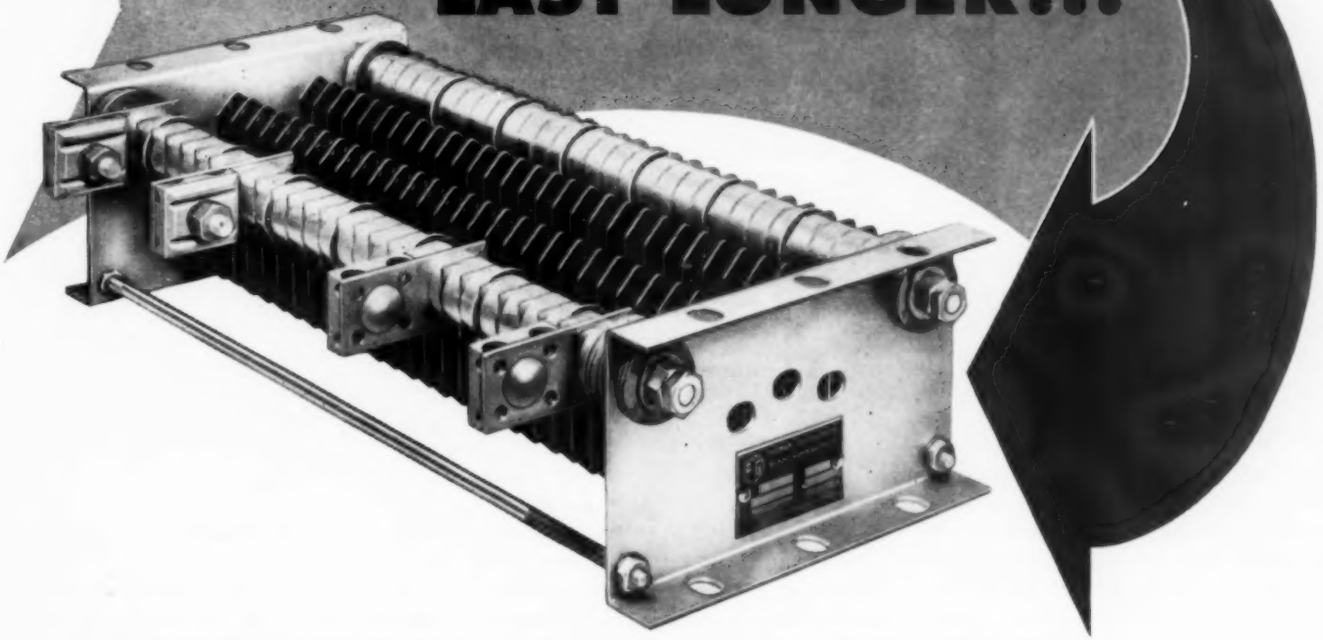

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Crucible Opens New Mill

AT MIDLAND, PENNSYLVANIA

▲ A new hot and cold rolled sheet and strip mill designed throughout for stainless and special alloy steel production is now in operation at the Midland works of Crucible Steel Co. of America.

Highlighting the new features of this $18,000,000 plant is a United 66-in. 4-high reversing mill using drum type coilers housed in gas-fired furnaces at each side. This is the only such mill in operation in this country. As presently tooled, the mill has rolled strip from 1 to 0.076 in. in thickness and widths from 15 to 50 in. Further reductions and greater widths will be produced later. At present, the mill will roll the widest strip produced on mills of this type, and it is ultimately capable of rolling sheet and strip up to 62 in. wide.

By use of furnaces and reels at each side of the mill, temperature can be conserved, permitting rolling to wider and thinner strip dimensions. Better control and maintenance of gage, better surfaces and improved finishes will be produced on the alloy steels which are the specialty of Crucible.

Designed and constructed to virtually double the company's output of stainless and specialty steels, the new plant will also process low carbon steels, tool steel, high manganese steel, agricultural implement and special alloy steels.

To achieve the maximum versatility in production of specialty steels, the equipment of the new plant is designed to permit the rolling of ingots to slabs and rolling from slabs to strip in all grades of steel. Also, some grades of steel may be rolled direct from ingot to strip. Steel strip, sheet and plate of an extremely wide range in grade will be rolled with an equally wide variety of widths and sections. The processing capacity of the mill will be 27,000 net tons of ingots per month of the special steels Crucible will roll.

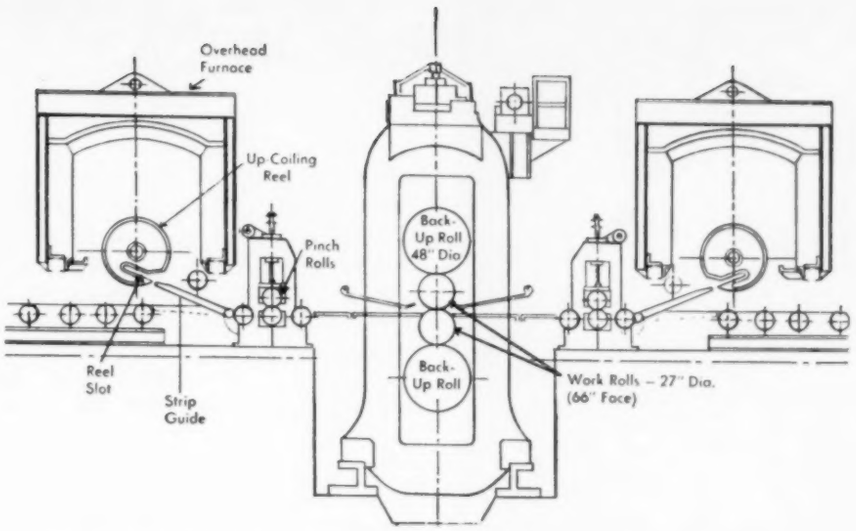
Aerial view of Midland Works of Crucible Steel Co. of America at Midland, Pa. In foreground is new $18,000,000 Sheet and Strip Mill, three-quarters of a mile of inter-connected buildings (535,000 square feet) for Crucible's continuous hot and cold rolling operations producing alloy, stainless and special purpose steel sheet and strip steels. At extreme left center is the new coke plant. Immediately beyond the storage yards for raw materials at center right are the blast furnaces and boiler house. The row of 12 stacks at top right marks the open hearth furnaces — and the left portion of the same building houses the electric arc melting furnaces.

A 14,000 sq ft stripper and ingot storage building is located at the head of the hot line. Ingots from open hearths or electric furnaces are stripped and prepared for furnace charging or stocked in this building. Ingots handled range in size from 9 x 15 in. to 20 x 55 in., weighing from 1100 to 24,000 lb. Charging cranes to handle these ingots consist of a five-ton Morgan crane and a new ten-ton Alliance crane.

HOT MILL

Ten batch type furnaces have a hearth area of 660 sq ft and a temperature range of 2150-2380 F. The usual heating cycle for ingots is 5 to 8 hours, although certain special steels require up to 24 hours of heating. Six of the furnaces are of the sprung arch type and four new ones are the latest Dietrick suspended arch roof types. Coke gas or natural gas is normally used, with oil as a standby furnace fuel. Temperature regulation, at present achieved with manual controls, soon will be fully automatic.

The first mill on the line is a 2-high, 32 in. diameter by 72 in. wide roll, broadside mill with a double reduction 1500-hp drive. This mill is used for scale breaking and cross-rolling of slabs to increase their width. The next unit is a 2-high, 33 x 69 in. 300-1200 rpm reversing slabbing mill with a 5000-hp direct drive. This mill reduces ingots to slabs of desired sections and reduces slab thickness to desired sections for further reduction in the 4-high reversing hot mill. Operating in conjunction with this mill is a 2-high edging mill with vertical rolls 28 in. in diameter by 30 in. high. Its speed is the same as the slabbing mill and it has a single reduction drive of



This drawing shows how upcoiling reels enclosed in furnaces operate in conjunction with the 4-high reversing mill. Strip passes through working rolls from the right on the first pass, and through pinch rolls. Strip guide is raised, directing strip into reel slot. Reel starts coiling automatically (each reel, driven by a 150-hp motor, rotates continuously unless stopped to place slot in position to receive strip end for coiling). Pinch rolls start strip back through when the mill is reversed for the next pass. Final pass always starts from right-hand reel, and steel is run out to the next process to the left of this mill.

1500 hp. The function of the edging mill is to reduce the sides of ingots to desired widths, usually from 4 to 6 in.

A Morgan slab shear and a slab conveyor are the next units on the hot line. The shear has guillotine blades 64 in. wide and is operated by two 150-hp motors through a single reduction drive. It shears slabs to specified length and crops rough sections of strip before it reaches the 4-high hot mill. The slab conveyor is 20 ft. wide with a counterbalanced chain which carries slabs from the rolling line to the adjacent conditioning building. Here, slabs are ground or scarfed and stored to await transfer back to the furnaces.

A scale flushing system is installed under the entire hot roll line to remove scale and carry it to a catch basin outside the building. About one carload of scale, composed of approximately 45 per cent iron, is removed each week for charging into the blast furnaces.

Of unusual interest on the hot line is the 66 in. United 4-high reversing hot finishing mill and its hot upcoiling furnaces. The work rolls are 27 in. in diameter and are direct driven by a 5000-hp General Electric motor. The back-up rolls are 48 in. in diamter and are operated by 100-hp screw down motors.

This mill is capable of 1200 fpm rolling speed. Ordinarily, five passes of the strip are sufficient to reduce strip to the desired finish gage. Lighter gages than are possible on the usual tandem stainless mill may be obtained, due to maintenance of temperature by the re-heat furnaces.

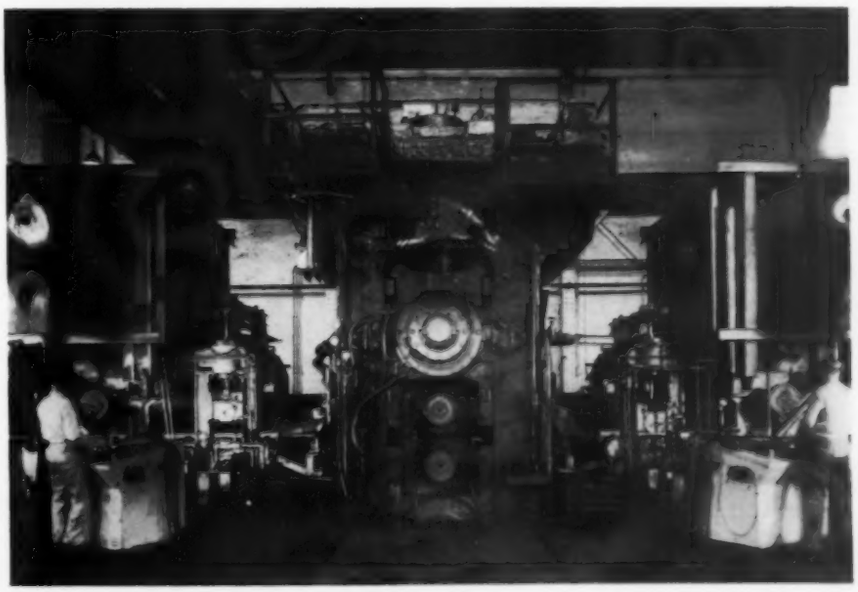
The mill back-up rolls have Morgoil bearings and the work rolls are fitted with roller bearings. A Farval automatic lubricating system oils the entire mill. A 52 x 168 ft motor room is equipped to regenerate current for the 4-high mill drive and contains all auxiliary and control equipment.

The reels in the Dun-Mar furnaces were made by the Calorizing Co. to United order. They each have a single slot and are driven by 150-hp motors. When the strip passes through the rolls, the reel receives the strip end and starts coiling automatically. The overhead furnaces are gas fired to a temperature of 1200 to 2100 F. Small pinch rolls are located on either side of the mill, between the mill and furnaces, to control the strip. Steam and high pressure water sprays are employed to remove scale.

Near the end of the hot line is a United 60 in. hot strip uncoiler. A bypass permits plate to continue to the 60 in. upcut plate shear. A 25,000 lb capacity upender is installed at the uncoiler to handle coils. A conveyor with double strand 12 in. pitch chains handles coils up to 56 in. outside diameter by 30 in. inside diameter, and 50 in. long, from the mill building to the storage building. A slitter and roller leveler for plates and sheet bar completes the hot rolling mill line.

A transept building at the end of the hot mill is divided into a storage area of 29,000 sq ft, for steel in process, and an annealing furnace area.

This unusual 66-in., 4-high hot reversing mill has upcoiling reels on each side, enclosed in gas-fired furnaces to conserve the heat in the steel, and is designed to hot roll all Crucible grades of stainless, alloy and high-carbon steels. This mill is the only one of its kind in operation in the United States. It hot finishes strip and sheet steels from 15 to 50 in. wide, with reductions ranging from 1 in. in thickness to 0.076 in. Overhead re-heating furnaces on either side, are fired at temperatures of 1200 to 2100 F. Steel passes through the rolls from the right on the first pass, and is coiled and kept hot in the left-hand furnace. The mill then reverses the process.



Shown here is one of the few large tandem mills for cold rolling stainless and alloy steel. The mill is a 56 in. three-stand, 4-high, tandem, cold rolling mill, capable of cold reducing special purpose steels in widths from 18 to 50 in. Fifteen hundred horsepower motors drive each work roll stand. Maximum rolling speeds of the stands are, starting with No. 1 stand at the right, 641 fpm; No. 2 stand, 780 fpm; and No. 3 stand at the left, 880 fpm.

The sheet annealing furnaces consist of four bases and two hoods with 22 ft 6 in x 8 ft 2 in., rectangular chambers. The coil annealing furnaces are of the bell type and consist of five bases and two hoods 5 ft 6 in. x 9 ft 7 in. in size.

STAINLESS ANNEALING AND PICKLING LINES

A new Midland annealing and pickling line for stainless and specialty steels incorporates the latest process details which have been evolved to meet the problems of handling alloy steels. The most complete processing equipment ever installed in a line of this type is intended to produce the finest finishes and virtually eliminate the possibility of damage to the valuable product.

At the entrance of the line is an uncoiler and leveler which uncoils, flattens and feeds the hot rolled strip. A 60 in. upcut hydraulic shear is next in line, to square strip ends before welding. Butt or lap welding of the strip, to permit continuous annealing and pickling, is performed by a 13 ft x 22 ft welding car equipped with a 600 amp d-c Heliarc welding machine.

A tension wiper is located at the entrance end of the annealing furnace to regulate tension and prevent the strip from dragging in the furnace. The furnace is 10 ft wide and 52 ft long, is fired with coke oven or natural gas. The furnace will continuously anneal and quench hot rolled chromium-nickel grades of stainless steel at 2200 F maximum. It can also be by-passed for pickling chrome grades of stainless steel.

The pickling tanks, to remove scale and clean strip for cold rolling, are of the hot acid type and are of steel construction, rubber covered. At the discharge end of the pickle line, a high pressure water spray, furnishing 100 gpm at 100 psi, removes loose scale from the strip. Pinch rolls 12 in. in diameter by 60 in. wide, of forged steel, feed the strip from the dryer to the shear, tension rolls, and coiler.

COLD ROLLING

This department possesses what is believed to be the first tandem cold rolling mill built for stainless steel. The number one stand is a United, a 4-high mill with 53 in. diameter by 54 in. face back-up rolls and 16½ in. diameter by 56 in. face work rolls. The mill drive is direct-connected to a 1500-hp motor. The screw down drive is 100-hp. Speed of the first stand is 641 fpm maximum.

Number two and number three stands in this tandem set have the same size work and back-up rolls and horsepowers. Their only variance from number one mill is in maximum roll speed. Number two stand has a speed of 780 fpm maximum and number three has a maximum speed of 880 fpm. This mill will cold reduce hot rolled and intermediate gage coils to required gage in widths from 18 to 50 in.

A 56 in. 4-high reversing cold mill with 53 in. diam by 54 in. face back-up rolls and 16½ in. diam by 56 in. face work rolls has also been installed. The mill is direct driven by a 2000-hp motor at a maximum speed of 850 fpm. Its screwdown drive is equipped with a 100-hp motor.

The function of this mill is to cold reduce hot rolled and intermediate gage strip to specified gage and to temper roll strip to obtain the required physical properties and finish. The gage range of this mill is from 0.018 to 0.187 in. in widths 18 to 50 in.

A 26 in. reversing cold mill has also been installed. This mill is a United 4-high reversing unit with 33 in. diameter by 26 in. face back-up rolls and is driven by an 800-hp motor at a maximum speed of 800 fpm. The work rolls measure 12½ by 26 in. and the screwdown drives are powered by two 13-hp motors. The function of this mill is the same as that of the 56 in. cold reversing mill. The strip product of this mill will range from 8 to 23 in. in width, 0.008 to 0.187 in. thick.

The skin pass mill is a 2-high single stand unit with 25 in. diameter by 26 in. face rolls driven by a 100-hp motor at a maximum speed of 200 fpm.

Also part of the installation is the No. 2 cold rolled stainless annealing and pickling line. Included in this line are two small and two large uncoilers which feed the strip to a welding car. Next in this line is a looping pit, an annealing or quenching furnace, which can be by-passed for pickling only, and three pickling tanks. A third No. 3 annealing and pickling line is also in operation.

Completing the installation are multiple slitting lines, welding, inspection, and surface conditioning lines; and the finishing and shipping departments.

Test Runs Made

ON HYDROCOL COMPRESSORS

▲ At the initial tests of part of the battery of centrifugal compressors for the first Hydrocol Process plant for making gasoline out of natural gas at Brownsville, Texas, it was stated that the combination of three Clark Bros. No. 5 compressor cases in the main air compressors will be the largest single shaft compressor ever built. This will also be the largest installation of centrifugal compressors in the world, consisting of 24 units having a total of more than 80,000 installed horsepower.

One of the Dresser Industries group, Clark Bros. specializes in compression of air and gases such as vapor recovery, refrigeration, and liquefaction of gases where high absolute pressures are involved and has developed a flexible line of centrifugal compressors to compress gases and air in the higher pressure ranges.

The No. 5 Hydrocol unit under test required considerable advance in engineering beyond any similar type of machine built in the past, either because of the relatively large volumes or pressures on both and the combination were such as to require a great deal of ingenuity and foresightedness on the part of Clark's engineering staff.

These centrifugals will compress six different kinds of gases varying from the air we breathe to pure explosive oxygen. The two main compressors will compress 110,000 cfm of air to 100 psi with a power requirement of 23,000 hp.

These centrifugal compressors consist of a number of impellers mounted on a common shaft, which is rotated at a very high speed by a steam turbine, requiring 125 tons of steam. Air or gas is introduced into the "eye" of the impeller near the shaft, after which it is thrown out at high speed toward the casing by centrifugal force.

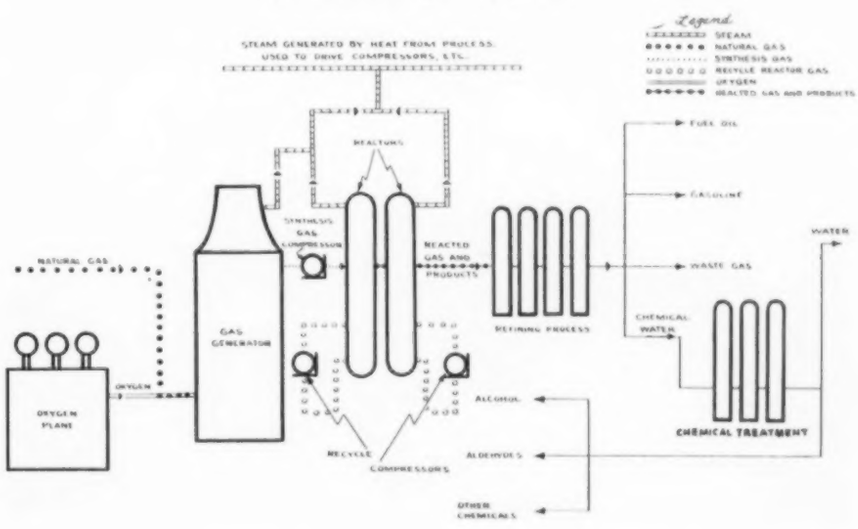
Compression of gas by this means is done, not by physically decreasing the volume, as with a piston, but by accelerating the gas to a high velocity then slowing it down somewhat in the compressor, changing velocity into pressure.

Figure 1 shows a very simplified diagram flow chart of the Hydrocol Process, oxygen and natural gas are partly burned in the gas generator to make synthesis gas. This synthesis gas is further compressed to a high pressure where it goes into the reactors and because all the gas is not converted the first time through, a recycle compressor which is also a steam driven centrifugal compressor is required.

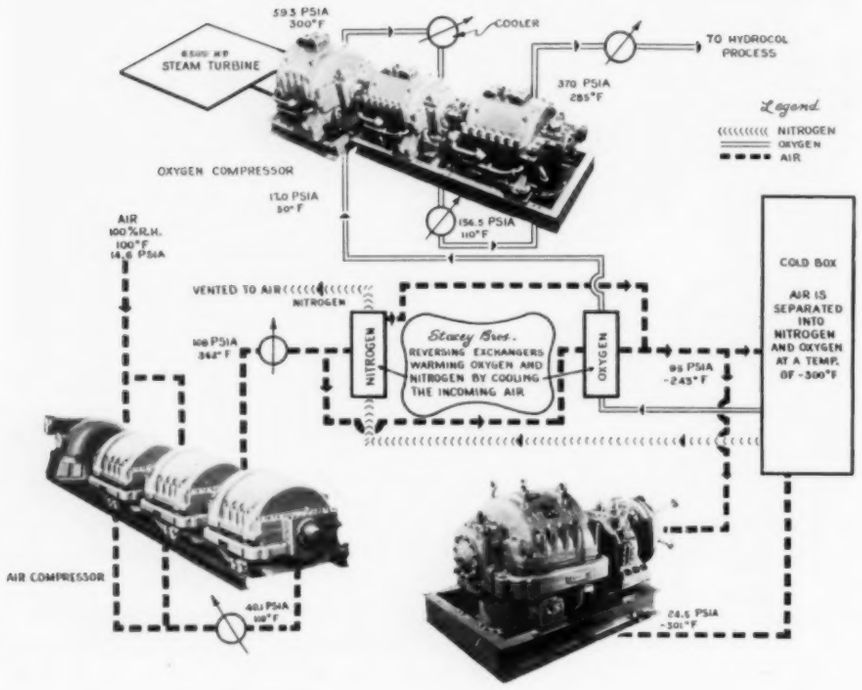
The gas generation and reaction are exothermic, which means that they give off heat. This heat is used to generate steam in such large quantities as to make the process practically self sustaining in steam required for its own power. Several steps of refining are required after reaction and the final products are fuel oil, gasoline, waste gas and chemical water. The chemical water is further treated and from it is removed alcohol, aldehydes, and heavier chemicals.

Figure 2 is a simplified flow chart of the oxygen plant. The main air compressor consists of three 4-stage centrifugal cases. Following the chart, the first 2 cases operate in parallel to boost atmospheric air to 40.1 lb absolute where it is cooled and then enters the third case and is compressed to 108 lb absolute. This entire unit, which handles 110,000 cu ft of air a minute, is driven by a 23,000-hp steam turbine. The high pressure air then passes through two specially designed reversing exchangers which cool the air, and eliminate the carbon dioxide and other impurities by warming the oxygen and nitrogen returning from the separation process. The cold air is put into a fractionating column called the cold box, whereby low temperature separation air is broken down into nitrogen and oxygen at a temperature approximately 300 F below zero. In order to get the necessary refrigeration for cooling, and partially liquefying the

Flow chart of hydrocol process



Flow chart of oxygen plant.



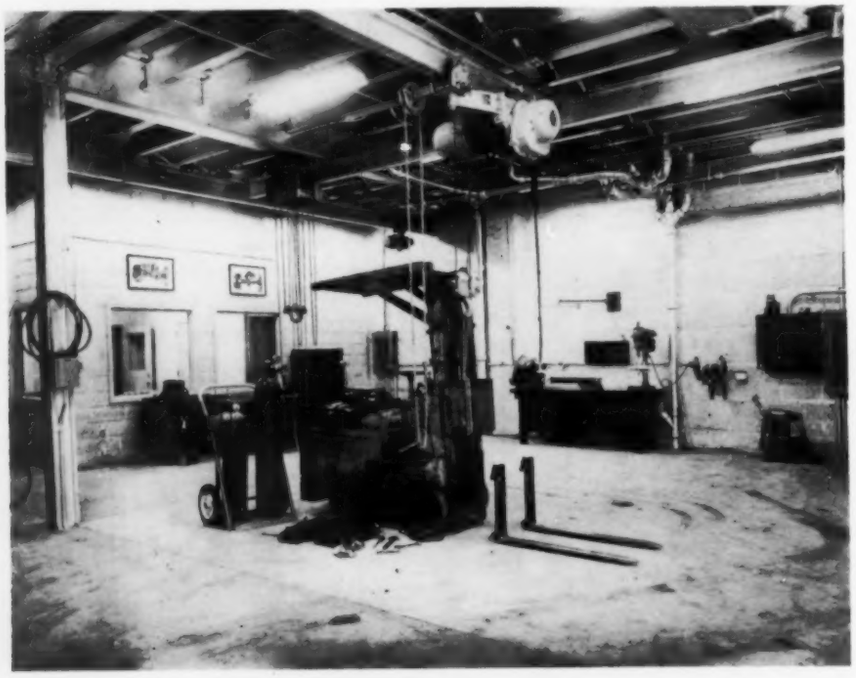
air, the expansion turbine takes cold air at 95 lb absolute and minus 243 F, and, after doing work in the turbine, is returned to the cold box at 24½ lb absolute and minus 310.

The prime purpose of this expander of course is to obtain the refrigeration necessary, but in so doing it develops approximately 450 hp which is used to drive an air compressor which, in turn, boosts air into the inter-cooler of the air machine, thus saving some power on the first stage of the main air compressor. After leaving the cold box and exchangers the oxygen itself is compressed in a 3-stage steam turbine driven centrifugal compressor from 17 lb absolute to 370 lb absolute. The design of this oxygen compressor is unique in that all possible safety precautions have been taken, such as, preventing contact of the oxygen and oil, and as an additional safety factor its internal parts are made of special bronze alloy and water cooled to maintain safe internal temperature, incidentally, also to improve the over-all efficiency of the compressor.

YALE & TOWNE OPENS SERVICE CENTER

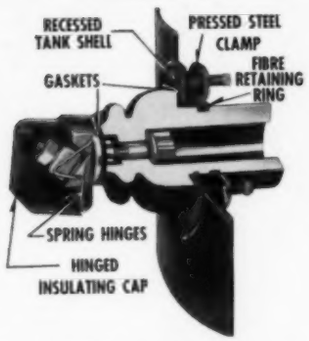
▲ The Yale and Towne Manufacturing Co. opened a new Pittsburgh regional branch sales and service building on May 20, located at 5845 Center Ave. In so doing, Yale and Towne are introducing an innovation in the servicing of industrial equipment and applying an idea which has long been of value to the automobile and trucking industry. This service center will be used for their materials handling equipment.

The building is two stories high and, in addition to making available factory trained and approved service, will carry a complete stock of spare parts, thus eliminating a possible source of delay in truck usage. Over 1,000 Yale part trucks are now in the Pittsburgh industrial area and they will be able to take advantage of the service under which power trucks can be completely overhauled, repaired and returned to their plants within a week to ten days. This center should be of particular value to the steel industry inasmuch as it is estimated that about one-half of the equipment in this area is operated by the steel fabricating and metal working industries.



In one corner of the repair shop is shown a 2000-lb capacity truck which is being overhauled in the new service center of the Yale and Towne Manufacturing Co.

NO POCKETS
ON THE
POLE STAR



Terminals receive line leads at the same angle as pocket-type bushings. Solderless connectors are forged of naval brass to assure a rugged connector of uniform strength. Heavy bakelite insulating caps are secured to the solderless connectors by spring wire hinges.

Caps are self-supporting above the terminals. Line connections are made with a standard wrench. Solderless connectors are completely exposed so lineman can see the connection he is making. Caps are closed by hand pressure and completely cover bushing terminals.

Embodying a new wound core design with an inherent low exciting current, Pole Star Transformers are made in sizes 25 Kva and below, 14400 volts and below, single phase, 60 cycles, OA, conforming to E.E.I.-NEMA Standards. Will soon be available in sizes up to 100 Kva.

Years ago, when bushings were neither weatherproof nor leakproof, pockets and pocket bushings were required on Distribution Transformers. In designing the Pole Star Transformer, however, Pennsylvania Development Engineers replaced the high voltage pockets and pocket bushings with sturdy, streamlined sidewall bushings. This was done because today bushings are provided with stud-type terminals and gasket seals which insure pressure tight joints and sealed tank construction. This is another one of the modern improvements incorporated into the Pennsylvania Pole Star Transformer. It is another example of Pennsylvania's Engineering Ingenuity.

** P. S. Let the Pole Star be your guide.*

Pennsylvania TRANSFORMERS — PENNSYLVANIA POLE STAR TRANSFORMER

If you want to know more about the Pole Star Transformer, write to us for Catalog No. 349.

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Powder-Cutting

Steps Up Production of Stainless Steel Castings 32 Times . . .

Centrifugally-cast rings of stainless steel are cut in 15 minutes time, increasing production 32 times.

Riser cutting of centrifugally-cast stainless steel rings used to be a difficult and time-consuming job. In one foundry which used a boring machine, this operation took eight hours per casting. When powder-cutting was introduced, the time was reduced to approximately 15 minutes—a 32-fold increase in production.

In another foundry, powder-cutting was profitably used to remove 3/8 to 1 in. of metal from stainless steel castings. The machining cost for this type of work has been $24.00 per casting. Substitution of powder-cutting brought the overall cost, including finish-grinding and chipping, to $7.53 per casting, and reduced the time from 8 hours to 1 hour. For an order of 60 castings, the foundry saved $988.20 and 360 hours of operating time.

If you have stainless steel or other oxidation-resistant metals to cut, LINDE's service engineers can show you how powder-cutting methods can be used with profit. Phone or write the nearest LINDE office.

Here, risers on stainless steel castings are being powder-cut—a time saving of 30 per cent over the former methods.

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A SELF-CONTAINED OIL-HYDRAULIC MACHINE FOR HANDLING PLATES OF FERROUS, NON-FERROUS AND CLAD METALS UP TO 132" WIDTH AND 31 FT. LENGTH

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THE WORLD'S LARGEST PLATE MILL
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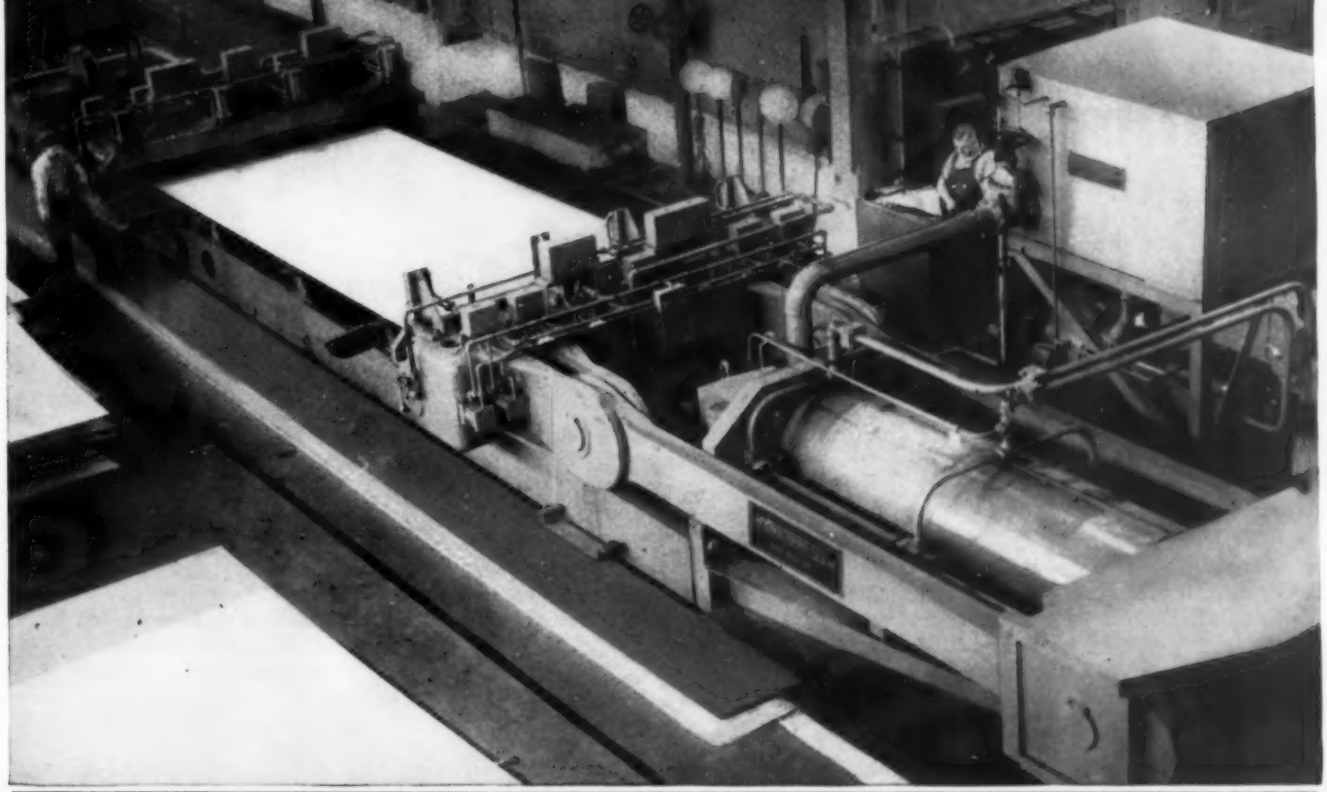

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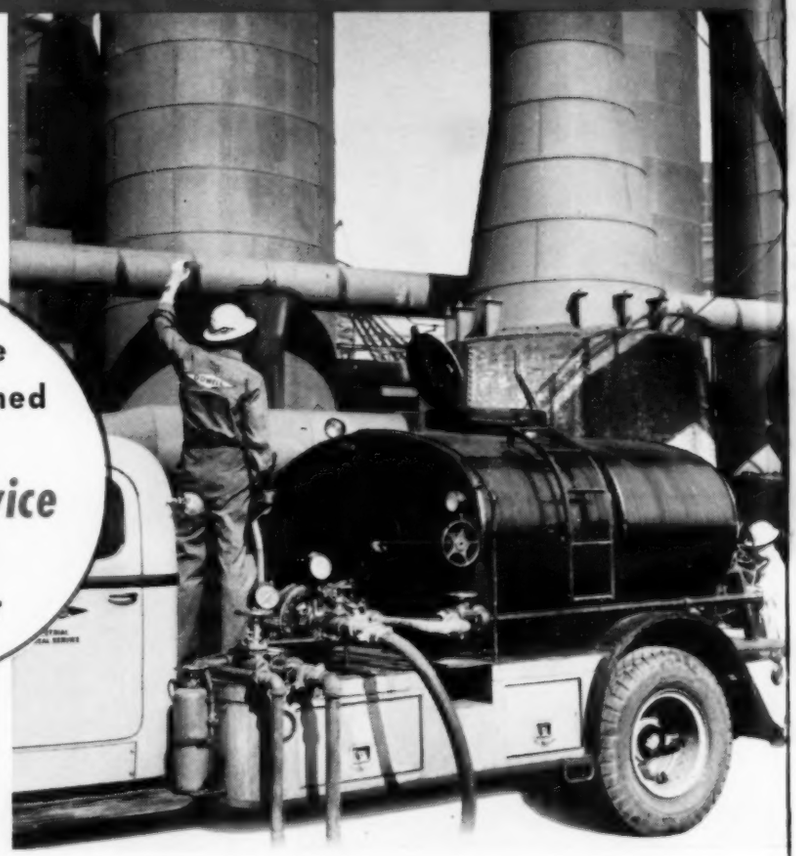

A blast furnace gas washer was operating with 23″ of water pressure drop while scrubbing 60,000 cu. ft./min. of blast furnace gas. Cleaning was imperative. *In two hours*, Dowell Service reduced the pressure differential of the washer to a normal of 7″ of water. The furnace top pressure had fallen from 60″ to 40″. At no time during the cleaning was it necessary to reduce the wind or in any other way interrupt gas washing operations!

Dowell Service, using the experience of thousands of successful jobs, offers you the solution to maintenance problems of this kind. It is backed by strong, continuous research programs, both in Dowell's own laboratories and in those of The Dow Chemical Company. This research provides the means for a constantly improving service with an ever increasing degree of effectiveness and safety.

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Long Beach, Oakland, Casper: Dowell Associate—International Cementers, Inc.

DOWELL

A SERVICE ORGANIZATION

Date-line Diary...

May 2

▲ The operating rate of companies having 94 per cent of capacity of the steel industry for the week beginning May 2, 1949 is scheduled to be 97.3 per cent. This is equivalent to 1,793,700 tons of steel ingots and castings compared with 1,797,400 tons one week ago.

▲ Irving S. Olds, chairman of the United States Steel Corp., stated that the steel industry had boosted capacity 18 per cent since 1940, and that 2,000,000 tons are scheduled for completion this year. He therefore criticized President Truman for proposing to use government funds to expand steel making capacity. This was done at the stockholders meeting today where the stockholders approved a three-for-one split of common stock.

▲ Tennessee Coal Iron and Railroad Company returned to blast the No. 7 blast furnace at the Fairfield Steel Works, after relining and enlarging.

▲ Republic Steel Corp. shut down No. 1 blast furnace at Birmingham for lack of merchant iron orders and also took No. 5 blast furnace at Youngstown out of production for relining.

May 3

▲ The Calumet & Hecla Consolidated Copper Co. stopped copper mining in its upper Michigan mines because there seems to be no demand for copper. These are high production cost mines.

May 4

▲ The Phelps Dodge Corp. cut the price of refined copper from 23½ to 20 cents a lb.

▲ The Independent Petroleum Association predicted that petroleum demand in the United States for 1949 will average 6,370,000 bbl a day or 4 per cent over 1948. This trims their previous estimate made several months ago down from an 8 per cent to a 4 per cent increase over 1948.

May 5

▲ The Census Bureau reported that unemployment decreased 151,000 between March and April. This is less than expected, as farm employment increased 427,000, while non-farm employment went down 255,000.

▲ Philip Murray stated that the CIO United Steel Workers will tell the steel companies that the union wishes to reopen its contracts for revision of wage and social insurance provisions.

▲ The Allegheny Ludlum Steel Corp. closed two more open hearth furnaces and laid off an additional 700 employees.

▲ Marketing affiliates of Standard Oil Co., (N.J.) have gone back to the practice of setting a ceiling on prices for heavy fuel oil. They have notified customers that heavy fuel oil will not be raised more than 40 cents a bbl in 1949, and no more than an additional 15 cents through June 1950.

▲ Deliveries of domestic freight cars in April totaled 10,587 according to the American Railway Car Institute. New orders during the month were 30, and the backlog or orders as of May 1 is now 62,569. April will probably be the last month in which the 10,000 car a month goal will be reached.

▲ CIO United Auto Workers walked out of the Rouge plant and the Lincoln-Mercury factory of the Ford Motor Co. today. The strike was called by the Union because they alleged that Ford is running its assembly lines too fast.

May 6

▲ United States exports in March rose to $1,152,000,000 from the February figure of $1,029,000,000 according to the Census Bureau.

May 7

▲ Kennecott Copper cut copper prices from 22½ to 18½ cents a lb.

May 9

▲ The operating rate of the steel industry is scheduled to be 96.2 per cent of capacity for the week beginning May 9, 1949. This is equivalent to 1,773,500 tons of steel ingots and castings compared with 1,793,700 tons one week ago.

▲ The F. W. Dodge Corp. reported that contract awards for April in the states east of the Rocky Mountains amounted to $842,586,000, which is a 13 per cent gain over March and a decline of 4 per cent for April 1948.

May 10

▲ No. 1 heavy melting scrap sold in Pittsburgh for $23.00 a ton.

▲ The Barium Steel and Forge Co. discontinued steel output at Canton, Ohio because they can obtain it elsewhere at a cost less than what they can make ingots themselves.

May 11

▲ The Department of Commerce reported that personal income in March was $2,000,000,000 below the February level. Income rate for the first quarter was down to an annual rate of $216,700,000,000.

May 12

▲ According to the American Iron and Steel Institute, production of steel in April was 7,783,807 net tons for a new record for the month. Operations averaged less than 100 per cent capacity for the first time this year. Steel production for the twelve months ending April 30 was over 92,000,000 tons which is a new record for any twelve month period.

▲ In a press conference President Truman stuck to his request for a $4,000,000,000 increase in income taxes as well as anti-inflation powers.

May 14

▲ The Association of American Railroads estimated that the carriers expect to haul 10.2 per cent fewer ton-miles of freight in 1949 than in 1948. Passenger traffic is expected to decline 12.8 per cent.

May 16

▲ Republic Steel Corp. closed down two open hearths in Buffalo and thus are operating at less than 100 per cent capacity for the first time since the beginning of the war.

▲ The operating rate of steel companies having 94 per cent capacity of the industry was scheduled at 95.6 per cent. This is equivalent to 1,762,400 tons compared with 1,773,500 tons one week ago.

▲ The Federal Reserve Board cut margin requirements for the purchase of securities by subscription rights from 50 to 25 per cent effective today. This 25 per cent margin is designed to restore preferential

credit terms for securities bought under subscription privileges.

May 17

▲ Production of goods and services for the first quarter of 1949 fell to an annual rate of $256,000,000,000, which is off $9,000,000,000 for the final quarter of 1948.

May 18

▲ Proposal was introduced into the house by Representative Mills, (Democrat, Ark.), which would provide that corporation taxes would be paid in March and June of 1950. This would advance the normal schedule of tax payments.

▲ The Lake Carriers Association reports that all previous tonnage records for the moving of iron ore in April were broken, with a new figure of 8,686,286 gross tons of iron ore.

▲ The Dominion Bureau of Statistics reported that Canadian iron and steel output for the first quarter of this year was up to 557,928 tons of pig iron and 842,939 tons of steel ingots and castings compared with 483,840 tons of iron and 782,398 tons of steel in 1948.

May 20

▲ Norman W. Foy of Republic Steel Corp. reported that his company's production of alloy steel has been cut to about 50 per cent of capacity because of lowered demand. In Canton, Republic is operating three out of six open hearths and three out of seven electrical furnaces. At Massillon, three out of nine open hearths are in operation.

May 21

▲ The Esso Standard Oil Co. reduced prices of heavy fuel oil about 15 cents a bbl.

▲ Department of Commerce reports that they expect to ease tin control during the second half of 1949.

▲ Chairman Sloan of the General Motors Corp. reports that the automobile and truck supplies will soon be balanced with existing demand.

May 23

▲ The operating rate of the steel industry for the week beginning May 23, 1949 is scheduled at 94.1 per cent of capacity. This is equivalent to 1,734,700 tons of ingots and castings compared with 1,762,400 tons one week ago.

▲ The Budget Bureau revealed that direct subsidies paid by the Federal government to farmers and businessmen totaled $14,525,217,000 for the fourteen fiscal years which ended on June 30, 1948. It was also estimated that $519,745,000 will be added for the fiscal year ending July 1, 1949, and an additional $526,098,000 will be added by July 1, 1950. The largest share of these subsidies were paid to farmers who received about $10,881,000,000 of this which also includes $4,973,000,000 paid for soil conservation practices.

May 24

▲ Total bookings of fabricated structural steel for April was 97,546 tons according to the AISC. This compares with 154,000 tons for April 1948. Shipments in April 1949 were 174,073 tons.

▲ General Motors Corp. cut truck and automobile prices from $10 to $40 per unit.

▲ Lead prices were cut 1 cent to a new price of 13 cents a lb in New York.

May 25

▲ The Alan Wood Steel Co. reduced its operations to 65 per cent of capacity because of shrinking demand for steel products.

▲ The Broken Hill Proprietary Co. Ltd., the largest industrial enterprise in Australia is planning to raise $22,400,000 for expansion purposes. Funds will be used for mechanizing coal mines and erecting a hot strip mill, a cold strip mill and a plant for producing steel plates.

▲ Refined copper prices slipped slightly to 17⅝ cents a lb.

May 26

▲ The Organization for the European Economic Corp. decided to abandon control of the distribution of scrap during the next three months because the supply is beginning to exceed demand.

▲ Crude oil production in Texas for June was set at 1,987,157 bbl daily or a decrease of 32,285 bbl from current daily allowable production.

▲ Republic Steel Corp. shut down its No. 2 blast furnace in Cleveland for an indefinite period. This furnace is used for producing merchant pig iron for foundry use.

May 27

▲ Mr. Walter S. Tower, President American Iron and Steel Institute, reported at the general meeting today that steel output may now be running ahead of actual consumption.

▲ The Federal Reserve Board reported that industrial production in April dropped to 179 per cent of the 1935-39 average compared with 184 per cent in March, 1949, and 188 per cent in April 1948. The index is now down sixteen points of the 1948 peak of 195 per cent.

May 28

▲ Because of the reduced demand for steel, the Carnegie-Illinois Steel Corp. is closing five open hearth furnaces in the Youngstown district. Electric furnace production is also being cut back.

▲ Natural rubber prices went down to their lowest level in two years and smoked rubber sheets are now being quoted at 16¾ cents a lb.

May 30

▲ Maintenance workers of the Ford Motor Co. returned to their jobs today thus ending their strike which started on May 5. Settlement will be based on arbitration. It may take several weeks before the company is in full production again.

May 31

▲ General Electric Co. announced reductions in net prices ranging from ½ to 7 per cent on polyphase and d-c electric motors and generators running from 100 to 200 hp.

▲ The National Safety Council reported that 1948 showed substantial reduction in frequency and severity of accidents to employees compared with 1947. For all industries, the frequency rate was 11.49 disabling injuries per 1,000,000 man hours or a 13 per cent reduction. The average accident severity rate was 1.12 days lost per 1000 man hours. For the steel industry, there were 5.86 disabling injuries per 1,000,000 man hours and the severity rate was 1.65 days lost per 1000 man hours. For steel, frequency was down 4 per cent and severity was up 3 per cent.

▲ Stock prices dropped in one of the biggest breaks since the election. Based on the Dow-Jones average, industrials went down 3.17 points and rails were off 1.83 points. Volume was 1,240,000 shares.

▲ The operating rate of the steel industry for the week beginning May 31, 1949 is scheduled at 91.8 per cent of capacity. This is equivalent to 1,692,300 tons of steel ingots and castings compared with 1,734,700 tons one week ago.

▲ Heavy melting steel scrap in Birmingham, Ala. was quoted at $18.00 a ton.

▲ The Republic Steel Corp. returned to operation the two open hearths at Buffalo which were taken out of service about two weeks ago.

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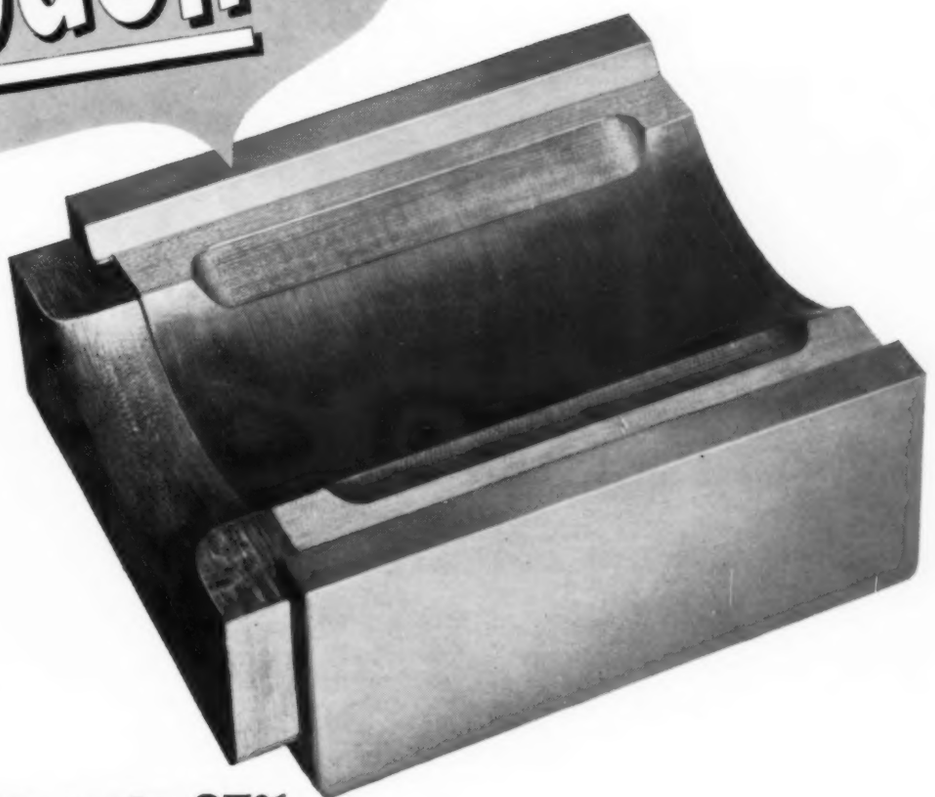
Micarta is really TOUGH



. . . cuts power costs 27%

Many examples are on record where Micarta Roll-Neck Bearings have substantially reduced power costs. This is because the smooth, hard surface of Micarta has a low coefficient of friction . . . saves from 20% to 37% of peak kva demand and kwhr consumption.

Micarta also eliminates grease costs, because Micarta uses water for lubrication . . . saves both grease and labor. Annual savings up to $5,000 are not unusual.

Water lubrication . . . plus the smooth, self-polishing surface of Micarta . . . prevents roll-neck scoring. Roll-neck life is preserved, too, because Micarta is chemically inert—prevents electrolytic action.

Slow, even wear . . . fewer replacements . . . fewer screw-down adjustments and test bars . . . prevention of "hot necks" and "fire cracks" are more reasons for using Micarta.

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Is MOISTURE your magnet problem?

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This unusual application proves the extra margin of moisture protection built into every Ohio Magnet.

For longer magnet life and greater dependability, why not send your next order to Ohio—*25 years a leader in magnetic materials handling.*

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SELECT YOUR MAGNET from two Ohio types. The PROTECTO-WELD magnet, shown here, is made in 39, 46, 55 and 65-inch diameters. Bolted construction types include these and other smaller sizes.

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Ohio MAGNETS

A-1924

Industry News...

TIMKEN REPORTS PHOSPHATE-COATING TREATMENT ELIMINATES INTERMEDIATE ANNEALING

▲ Engineers and operating supervisors of Timken Roller Bearing Co.'s Gambrinus, Ohio, plant report that use of a special phosphate-coating treatment for steel tube stock to be cold-drawn (1) aids it to retain lubricant longer; (2) permits greater reduction per pass and faster drawing, and (3) results in less damage to tubing and dies.

In some instances this phosphate compound, known as "Banox," has made it possible to give steel tubing a double pass without intermediate annealing formerly necessary, the Timken engineers reported.

Timken men pioneered the use of the treatment, working in collaboration with chemical engineers of Calgon, Inc., Pittsburgh manufacturer of the phosphate material.

Unlike other phosphate materials first used for this pre-drawing treatment, Banox requires no heat for application, the Timken engineers said. Bundles of tubing are immersed for two minutes in an unheated 1¼ per cent solution of this phosphate compound in the pickling department, before "doping" with cold-draw lubricant. Thus it is economical to use, and does not add to the fuel consumption of the plant.

This is the first known use of Banox in tubing manufacture, according to chemists at Calgon, Inc., although it has been successfully employed as a lubricant aid in wire-drawing at the Aliquippa, Pa., works of Jones & Laughlin Steel Corp., as well as at several other wire mills. Also, it is being employed as a rust-retardant and paint-bonding coating by several manufacturers of fabricated steel products to be painted, such as outdoor furniture, kitchen ranges, washers and ironers, automotive equipment and similar items.

At Timken's Gambrinus plant, where this phosphate treatment for cold-drawing tube stock was pioneered, round billets are pierced and rolled, then hot-pointed on a hydraulic squeeze pointer; next they may be annealed, depending on specifications, then go to the "pickle house." There the tubing stock is pickled by conventional immersion methods, in reel-type or still tanks containing 15 per cent sulphuric acid solution. A hot rinse (150 F) follows, then the bundles of tube stock are immersed for two minutes in the unheated 1¼ per cent Banox solution, and finally go into another rinse prior to "doping" with a special cold-drawing lubricant developed by Timken lubrication engineers.

The Banox solution is easily maintained at proper strength by simple addition of small amounts to the tank as required. The solution does not precipitate a hard sludge with continued use, so that cleaning of the tank entails only emptying and flushing with water.

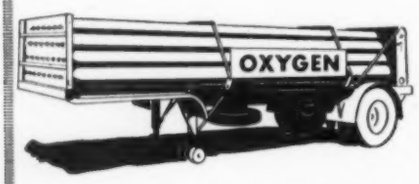
Opinion as to why this phosphate material is effective as a lubricant-aid, or as a lubricant in itself, is divided. One theory advanced—that the film it forms is absorbent, and therefore retaining lubricant longer than it would normally adhere to tubing during cold-drawing — is discounted by Calgon chemists on grounds that the film is too thin to be capable of such action.

They explain that Banox "plates out" on steel surfaces as an amorphous phosphate film, microscopically thin, perhaps 15 millionths-inch, yet plastic and continuous, and closely following contours of the metal surface. It is deposited spontaneously from an unheated solution without

TRACER-CONTROLLED ENGINE LATHE IS SHOWN TO ROLLING MILL OPERATORS

Completion of the first successful tracer-controlled engine lathe to be designed expressly for turning steel mill rolls was announced May 11 by Monarch Machine Tool Co. Shown below is a group of steel mill operators who inspected this new lathe at the company's plant. Details on this lathe appear on Page 83 of this issue in an article by S. A. Brandenburg, vice president of Monarch.

WHO PAYS THE FREIGHT?



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visible attack on the metal surface, thus differing radically from the older coatings which were used as an aid in the cold forming of steel.

In its conventional use as a room-temperature rustproofing and paint-bonding material it is capable of enabling paint to withstand bending stresses and impact with less likelihood of damage, they report.

PRESENT CAPACITY NEEDS HUGE MATERIAL SUPPLY

▲ One hundred and eighty tons of steel, every minute of the night and day during the entire year—that is what the steel industry is able to produce with its present record ingot capacity.

Such high production calls for larger quantities of raw materials than have ever been assembled by the steel industry. Nearly 250 tons of iron ore will be required each minute as well as 203 tons of coal and large quantities of other materials, some from distant parts of the world.

To transport a year's ore, coal and limestone would require nearly 5,500,000 freight cars, loaded to 50 tons each, for one trip each.

The metallics to produce 96,120,930 tons of steel per year must come mainly from two sources; iron made in blast furnaces and steel scrap. About 130,000,000 net tons of iron ore will be required per year.

More than 50,000,000 tons of scrap will be required a year, most of it yielded by the mills in their own operations. That tonnage will include a minimum of about 18,000,000 tons of purchased scrap, assuming the industry gets the benefit of full operations at blast furnaces. In 1948, however, about 25,000,000 tons of purchased scrap were used.

About 35,000,000 tons of limestone will be needed a year; 1,546,000 tons of manganese ore; 634,000 tons of chrome ore; and 144,000 tons of metallic nickel. For the latter three materials, the United States has been largely dependent upon imports. About 90 per cent of this country's total requirements of manganese ore is normally brought from foreign countries, some of them far distant. Russia, Africa, India and Brazil are the chief suppliers. Shipments from Russia in recent years have totaled about one-fourth of the ore consumed in this country.

When the industry's possible requirements for fuel and energy are computed, the figuring gets into billions—well over two billion gallons of fuel oil; 300 billion cubic feet of natural gas; 12 billion kilowatt hours of purchased electricity. These are possibilities, judging from consumption in the past. They do not include energy required in mining and transportation.

The coal equivalent of the fuels other than coal will be 16,000,000 tons per year. That, however, pales before the 94,000,000 tons of coal required to supply blast furnace coke, and the estimated 17,500,000 tons for other purposes—a total of 111,500,000 tons of coal per year to produce 96,000,000 tons of steel ingots and 70,000,000 tons of pig iron and ferroalloys. Most of that pig iron is used in steelmaking.

All the foregoing figures respresent some of the principal materials for only one year of capacity production.

UNITED ENGINEERING MOVES HEADQUARTERS

▲ United Engineering & Foundry Co.'s new general office building, at 948 Duquesne Way, Pittsburgh, Pa., was formally opened June 10.

The new United Building houses from 500 to 600 officers and employees of the company in its executive, legal, sales, engineering, research and development, production, purchasing, traffic, treasury and industrial relations departments, whose growing numbers had made it impossible to accommodate them altogether suitably in rented quarters. Manufacturing activities are carried on elsewhere in Pittsburgh, in Vandergrift and New Castle, Pa., and in Canton, Youngstown, and Akron, Ohio.

GARY MODERNIZES COLD REDUCTION MILL

▲ Modernization of a three-stand cold reduction mill for Carnegie-Illinois Steel Corp. at the Gary, Ind., sheet and tin mill has just been completed by F. H. McGraw & Co. Modernization of the three-stand mill, which consisted mainly of electrical, mechanical, and piping work, got underway late in March and required a 45-day shutdown of operations.

"We have no fear of any sudden breaks with Monel Pickling Chain on the job!"

You'll always find pickling-room foremen confident of safety with Monel* chain.

Take the chain shown above. It's ¾" Monel, and has been in pickling service over 6 years. In the same plant is another chain, a 1¼" cast acid-resisting chain. Yet, for the heaviest loads, they use the lighter Monel chain because "*. . . we find it reliable and not subject to sudden breaks, as is the case with the cast acid-resisting chain.*"

For over 40 years, Monel has paid its way in pickling service, because Monel resists corrosion by hot pickling acids and fumes. It's stronger and tougher than structural steel. And, Monel welds retain full strength, full corrosion resistance.

So, whether you use chain as slings or in mechanical picklers . . . for longer life and greater safety that chain should be *Monel!*

*Reg. U. S. Pat. Off.

"PICK" MONEL *for all types of pickling equipment. In addition to chain, you can have crates, baskets, tie-rods, hairpin hooks and other pieces fabricated to your design out of economical standard mill forms. For more information on Monel and Monel fabricators, write to our Ray Reddell.*

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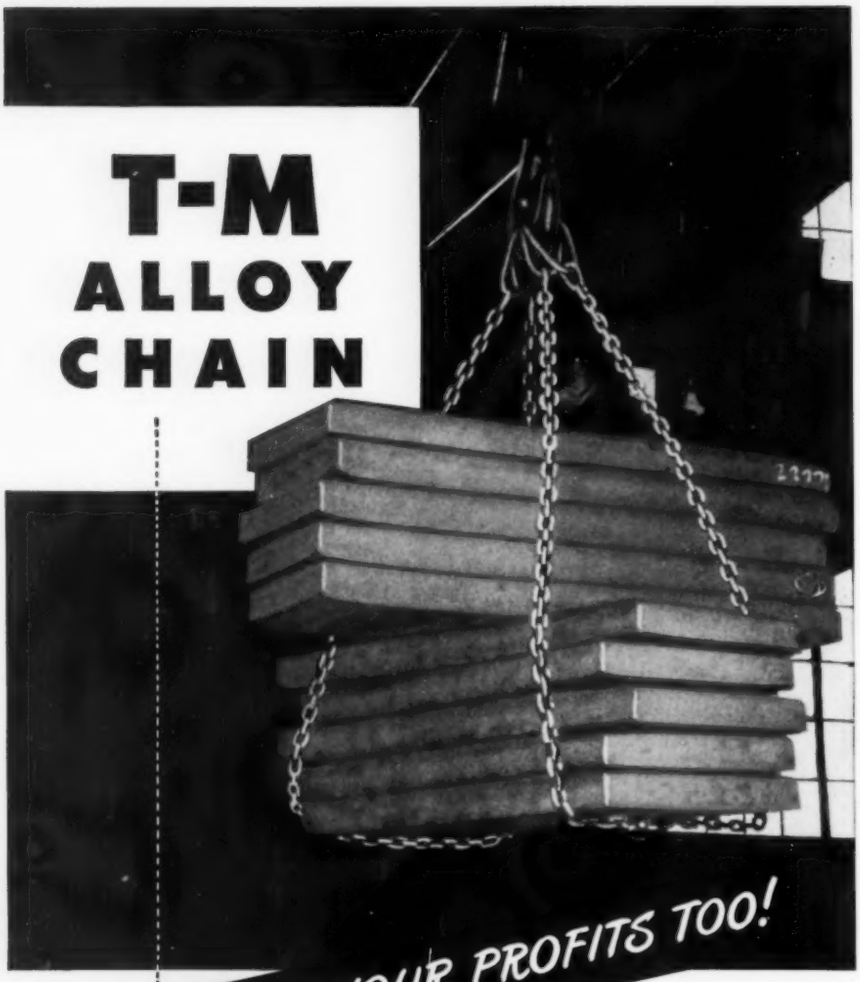
"MONEL*" Pickling Equipment means *Extra CAPACITY . . . Extra LIFE . . . Extra SAFETY*



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75th ANNIVERSARY ★

TAYLOR MADE *Chain*

PER CAPITA OUTPUT SHOWS INCREASE

▲ The record production of steel in the first quarter of this year was equal to annual output of over 1300 pounds of raw steel for each person in the United States, an increase of almost eight per cent over 1948 per capita output and more than 50 per cent over a decade ago, American Iron and Steel Institute announced recently.

As announced previously by the Institute, the new monthly record output of 8,388,965 net tons of ingots and steel for castings in March brought the total for the first three months of 1949 to 24,053,181 tons, nine per cent higher than a year earlier, or more than half the average annual output of the 1920's.

Continued production at the March rate, averaging nearly 1,894,000 tons a week, would make an annual total of over 98,000,000 tons of steel, an increase of 10,000,000 tons over 1948 output.

Production is breaking records not only in total tonnage, but in relation to growing population, the Institute said, and the effect of this greatest steel production cycle is being felt everywhere in supplies as the factories of the country are rapidly balancing supply and demand for their products. The Institute pointed out the country has been getting the benefits from steel's large scale expansion and improvement programs not only in the record first quarter, but through the entire past year. In the latest 12 months more steel was produced than ever before in a similar length of time. The total of more than 90,000,000 tons for the 12 months ending March 31 was 1,500,000 tons greater than in the calendar year of 1948.

Shipments of finished steel exceeded 18,000,000 tons in the first three months of 1949, equal to more than half of total 1939 shipments.

Steel companies increased their annual ingot capacity by about 1,800,000 tons in 1948 and plan to add nearly 2,200,000 tons this year. By the end of 1950 these programs call for capacity of almost 99,000,000 tons, an increase of more than 20,000,000 tons since 1937. Steel companies spent $583,000,000 in 1948 and

THE NEXT MOVE IS YOURS

FOR GEAR DRIVES, PINION STANDS OR COMBINATION UNITS — built to suit your needs exactly—you only have to tell us your requirements. We will do the rest, supplying you with a *designed-for-the-job* unit capable of withstanding the shocks, stresses and wear encountered in continuous, heavy duty service.

REDUCTION GEAR DRIVES — Single, double and multiple reduction units, in a wide range of ratios and capacities. Precision cut gears, generated by the famous Farrel-Sykes process, provide extra load-carrying capacity and smooth, quiet operation.

PINION STANDS — Double or single helical pinions mounted in sleeve or roller bearings, carried in heavy cast cases and provided with automatic lubrication. Built in any size, for any capacity.

COMBINATION UNITS — Include reduction gear drive and pinion stand in a compact, integral unit.

The next move is yours. Why not call on us when planning your new mill drive? Our engineers will be glad to discuss gear drive problems with you at any time, without obligation.

FARREL-BIRMINGHAM CO., INC. • ANSONIA, CONN.
Plants: Ansonia and Derby, Conn.; Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston

Farrel-Birmingham

FB-477

expect to spend $627,000,000 in 1949 on new plants and equipment.

The rapidly rising trend in production of raw steel is indicated by the following figures: From average monthly production of 5,951,728 net tons in the final quarter of 1945, output rose to a monthly average of 7,074,506 tons during 1947 and advanced to 7,377,811 tons in 1948, followed by the sharp rise in the first quarter of 1948 to a monthly average of 8,017,727 tons.

When making inquiries, please mention the IRON AND STEEL ENGINEER

PROCESS ADDS 25 PER CENT TO MOTOR FUEL SUPPLY

▲ Colonel Ernest O. Thompson, Commissioner of the Railroad Commission of Texas, at Austin, and nationally recognized authority and exponent of oil and gas conservation, stated that "The Hydrocol Process (for making gasoline out of natural gas) can easily mean an added 25 per cent to the motor fuel supply of America." Initial tests were made on part of the centrifugal compressors, which are being shipped to Brownsville, Texas, where they will be installed in the first Hydrocol Process plant for making gasoline out of natural gas to be built in this country.

Assuring that there is plenty of gasoline for everyone to drive anywhere and stay as long as they desire, and ample oil to keep everybody warm who wants to use oil for heating, Colonel Thompson backed up his statements with some imposing facts, to wit:

"The refineries have increased their plants by one million barrels per day capacity.

There will be ample heating oil on hand for keeping everybody warm who wants to use oil for heating. We are discovering more oil all the time.

"Last year, 1948, we consumed 2 billion barrels of oil, but ended the year with a 2 billion barrel increase in petroleum reserves.

"So put this down and tell the world—we here in the U. S. are not running out of oil. We are building up reserves.

"In my state of Texas alone, we have shut in 800 thousand barrels daily oil production because the market demand is filled and stocks on hand, both oil and gasoline, are at present ample.

"It might be proper to make clear that heavy imports of crude last winter and a light winter conspired to fill up stocks. But it is reassuring to the consuming public to know that we are not short of oil. This new process will be all the more assuring of an ample supply of motor fuel."

For Improved Drawing and Longer Die Life

Copper-coat WIRE, ROD and TUBING with

Cuprodine®

"Cuprodine", in a simple chemical process without current, deposits an adherent layer of copper on both mild and stainless steels. This layer acts as an effective lubricant—reduces wear and scratching of dies; prolongs die life; minimizes scratching on wire, rod and tubing; and increases the number of draws per die.

CHEMICALS ACP PROCESSES

RUST PROOFING AND PAINT BONDING
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"Cuprotek"® passivates Cuprodized and other cuprous surfaces, and acts as a paint bond, or a good temporary preventive of corrosion.

Write or call Ambler 0486, for further information on both "Cuprodine" and "Cuprotek".

Pioneering Research and Development Since 1914

AMERICAN CHEMICAL PAINT COMPANY

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Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

C-I ANNOUNCES NEW BESSEMER BAR STOCK

▲ A new bessemer steel bar stock, called "MX" free machining steel has been announced by Carnegie-Illinois Steel Corp.

When used in automatic screw-machine operations, "MX" steel provides substantially longer tool life and greatly improved surface finish of parts with up to 20 per cent increase in machinability over standard bessemer steel bar stock of comparable grade. It has been under development by this United States Steel Corp. subsidiary for over five years.

"MX" free machining steel has been developed specifically to augment the machining characteristics of Grade B-1113 steel in many appli-

yes... an oil seal that's tailor-made to *resist* corrosion

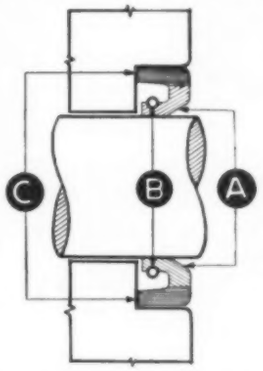
● If corrosive conditions are shortening the life of your oil seals, the Johns-Manville Clipper Seal should provide a practical solution to your problem.

Here's why: The Clipper Seal's molded body is entirely non-metallic and is, therefore, unaffected by most forms of corrosion. To meet special conditions, the garter spring which holds the lip in contact with the shaft can be furnished in various corrosion-resistant metals . . . *or Clipper Seals of special design that do not require garter springs may be used.*

The one-piece, concentric molded design of Clipper Seals also assures a number of other advantages. The hard, tough outer heel of the Clipper Seal is resilient enough to conform even to a slightly out-of-round cavity. And the soft, pliable inner lip always maintains a light, but positive sealing pressure on the shaft, with minimum wear on the seal.

Clipper Seals are quick and easy to install, may be had in split or endless types, are available in sizes from ¼" I.D. up to 66" O.D. If you have a special sealing requirement, or wish to consult about a special design problem, write Johns-Manville, Box 290, New York 16, N. Y.

Here's how *Clipper Seal* works:



The flexible lip (A) is held in light but firm contact with the shaft by means of the garter spring (B). Pressure on shaft is carefully pre-determined to minimize wear, yet effectively seal against leakage. The rigid heel (C) provides a press fit in the cavity, assuring a tight lubricant-retaining seal at this point also.

Johns-Manville **PACKINGS & GASKETS**

cations where that grade was recommended formerly. The new steel at the same time has been shown to perform well in subsequent operations such as forming or crimping the machined parts. It has been used very successfully on extensive production test runs in the manufacture of automatic screw-machine parts.

"MX" steel is available in hot rolled bars from Carnegie-Illinois Steel Corp., and in cold finished forms from cold finishing plants.

ALUMINUM ROLLING MILL BOUGHT BY SWISS FIRM

▲ Aluminum Foils, Inc., has announced placing an order with Lewis Foundry & Machine division of Blaw-Knox Co. for mill equipment for rolling aluminum foil in a new plant now being erected at Jackson, Tenn. The contract is unusual because it represents the investment of foreign capital in new enterprise within the United States.

Aluminum Foils is a wholly owned subsidiary of the Swiss Aluminum Co. (S. A. pour l'Industrie de l'Aluminum) of Lausanne, Switzerland. The company reports that its new plant in Tennessee will be one of the most up-to-date installations in the world for rolling very thin gage aluminum foil.

The award to Blaw-Knox involves more than one million dollars and covers several stands of Lewis 2-high and 4-high mills, as well as all auxiliary rolling equipment. Lewis reports that the units of this order will be designed to give a high yield of precision rolled foil in thicknesses down to .0002 in.

LIQUID CONDITIONING FIRM IS ACQUIRED

▲ Cochrane Corp., Philadelphia, Pa., has announced the acquisition of substantially all of the capital stock of Liquid Conditioning Corp., Linden, N. J.

Liquid Conditioning Corp. will operate as a wholly owned subsidiary of Cochrane, and the products of the former, comprising a complete line of equipment for the conditioning of water and other liquids, marketed under the trade name "Liquon," will continue to be sold under that name.

LARGEST TRANSFORMER SOLD TO CENTRAL STATION

▲ The largest capacity transformer ever built was shipped recently from the Westinghouse transformer division at Sharon, Pa., for installation at the Trenton Channel Station of the Detroit Edison Co. The transformer is three-phase and will step up generator voltage of 15,000 volts to 135,000 volts for transmission service.

Despite its tremendous capacity, modern engineering developments, including shell-form, "Form-Fit" construction, result in smaller physical size and lighter weight than possible even with much less powerful transformers in the past. The transformer was placed on a depressed-bottom car and shipped upright completely assembled except for bushings and cooling units. It is cooled by

Cuts Pickling and Drawing Costs

In Major Ohio Steel Plant

"First things come first," states an old saying, and that's why this Weldco Mechanical Pickler is an important addition in the Cold Drawn Division of an Eastern Ohio steel mill. For the success of the cold-drawing operation depends on the proper pickling of the bars, and this pickling-descaling job comes "first."

The Pickler shown here is a 7½-ton Mechanical Bar Pickler in a floor-level tank 5' x 5' x 43'. This equipment pickles 120 tons per turn—rounds, squares, hexagons, and flats. The spreaders, chains, and foundation bolts are made of long-lasting, corrosion-resisting Monel.

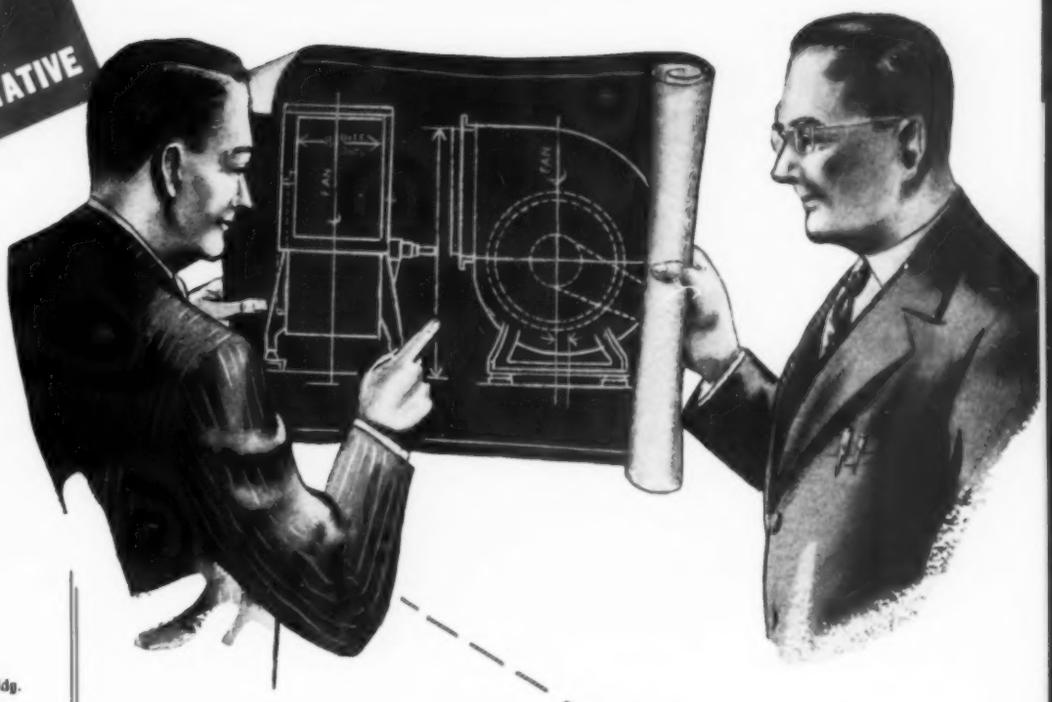
Production records in this Ohio steel plant show a uniform, complete descaling operation, reduced pickling and drawing costs, longer die life, and fewer rejects at the drawbench . . . . all of which indicate a sound investment in pickling equipment that will soon pay for itself.

Weldco Mechanical Picklers are also available for pickling coils, tubing, and sheets . . . can be built to any capacity. Write today for complete information and descriptive literature.

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

3718 OAKWOOD AVENUE . . . YOUNGSTOWN 9, OHIO

YOUR "Buffalo" ENGINEERING REPRESENTATIVE



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CLEVELAND 13
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Call in your nearest "Buffalo" Representative—his "Air Know-How" is at Your Service

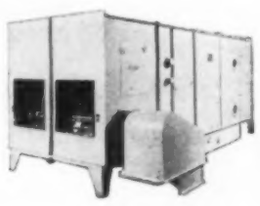
READY AND COMPETENT
to work with your consulting engineer
ON YOUR AIR PROBLEMS

To make your investment in air pay you maximum dividends, it's more than a matter of buying a *good* fan or a *good* air conditioning unit. In today's complex air handling problems, proper selection of equipment is often the only answer — plus an effective *link* between your own engineer and the firm supplying the equipment.

This is one of the reasons why "Buffalo" installations have been so satisfactory to users. "Buffalo" equipment, a complete line of field-proven fans and air conditioning units — *plus* the "Buffalo" representatives at left — give you this ideal combination.

"Buffalo" representatives know their equipment and the jobs it is designed to handle. They are Graduate Engineers with one to five years of factory training, in addition to wide field experience. And they have all the resources of the "Buffalo" home plant engineering staff to back them up.

Buffalo Air Conditioning Cabinet



Buffalo Air Washer

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"Buffalo" FIRST FOR FANS

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VENTILATING AIR WASHING AIR TEMPERING INDUCED DRAFT EXHAUSTING

forced-oil and water, Four hundred gallons of water per minute will flow through four coolers installed in an underground vault.

The transformer completely assembled and filled with its 6,000 gallons of oil and ready for service will weigh 121 tons. Even with modern, compact design, the bushings rise over 23 ft above the base.

Engineering developments represented by this unit have materially reduced transformer costs. If this capacity in transformers had been built according to practices of ten years ago, four single-phase, self cooled units would have been used. Their costs would have been more than twice as much as that of this modern three-phase transformer.

GREAT LAKES CARBON INCREASES PRODUCTION

▲ The Great Lakes Carbon Corp. will greatly increase its electrode production this summer when it begins commercial operations at its Morganton works, Morganton, N. C. For nearly two years the North Carolina graphite electrode plant has been utilized for the Atomic Energy Commission.

Consisting of 25 major and minor buildings which cover about one-half of the 44-acre tract, the new electrode plant is said to be the most modern, best equipped works of its kind in the world. Although purchased by the carbon corporation two years ago, the Morganton unit has been withheld from commercial production until the projects for the AEC had been completed.

Production schedules at the huge plant are being developed so that regular shipments of graphite electrodes, anodes and specialties will begin this summer. The capacity of the Morganton works, added to that of Great Lakes' Niagara Falls, N. Y., plant, will provide steady and uninterrupted service in a complete line of quality graphite and carbon products for the basic industries where such products play essential parts. By the last quarter of 1949 it is expected that adequate production to meet the needs of these industries will be achieved.

BANTAM BEARINGS MOVES CHICAGO OFFICE

▲ Torrington Co., Torrington, Conn., and South Bend, Ind., announces for their Chicago office a new location at 4352 West Roosevelt Road, Chicago 24, Ill. The office was formerly at 176 West Adams St. The new phone number is SACramento 2-5703.

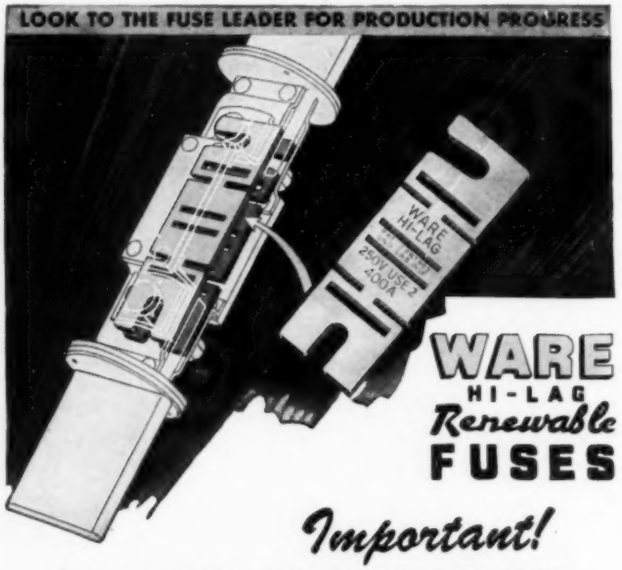
COLD ROLLED STEEL SHOWS HIGH INCREASE

▲ Shipments of both cold and hot rolled steel products have increased sharply since prewar 1940 according to American Iron and Steel Institute. Although annual shipments of hot rolled products are still greater than those of cold rolled products, the latter have greatly increased their share of the total.

The fact that all the horsepower goes through the coupling emphasizes the importance of protecting direct-connected machines against misalignment.

AJAX FLEXIBLE COUPLING CO. INC., WESTFIELD, N. Y.

LOOK TO THE FUSE LEADER FOR PRODUCTION PROGRESS



WARE HI-LAG Renewable FUSES

Important!

HI-LAG LINK DESIGN

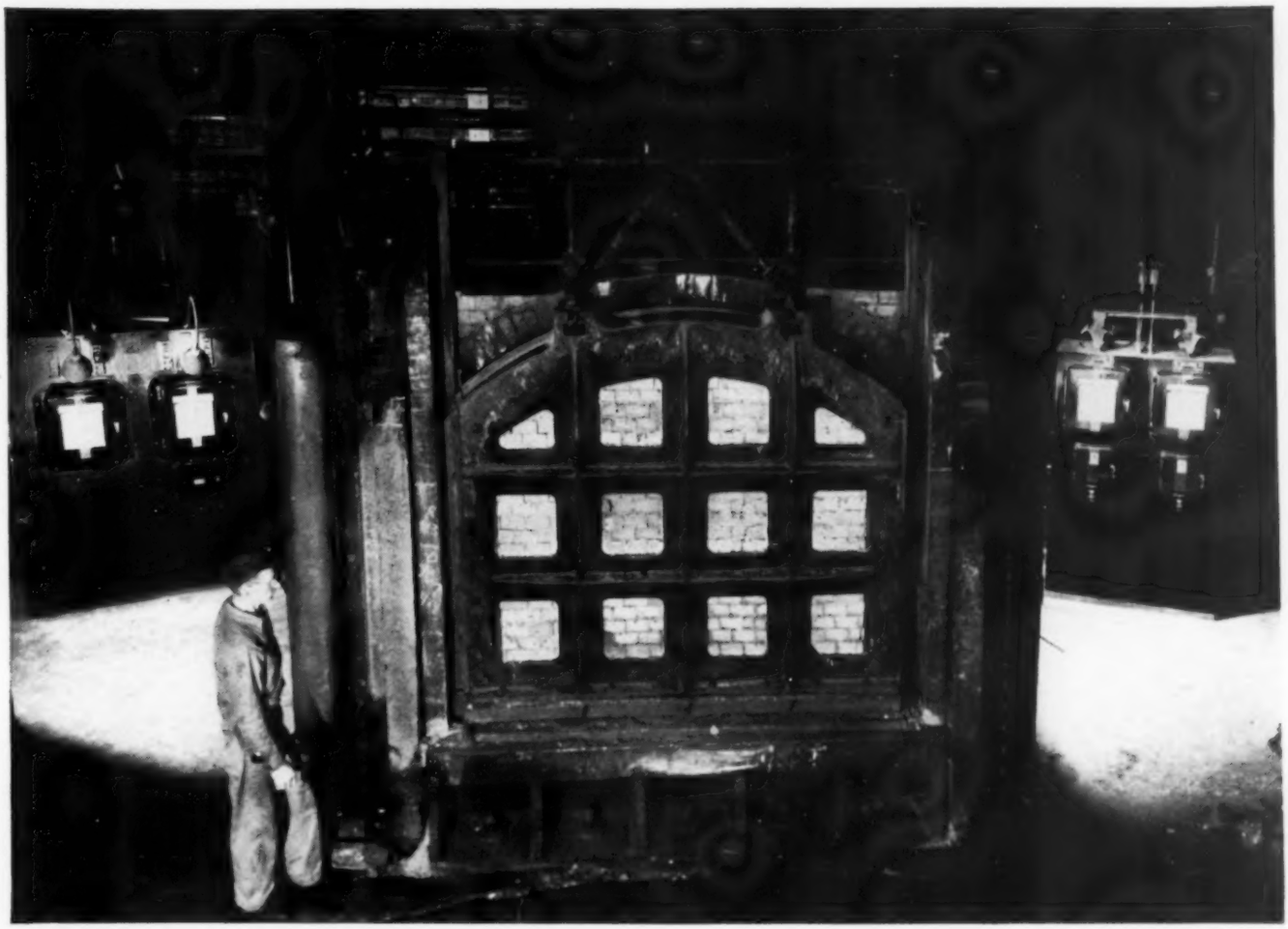
1. Square ends increase contact areas and maintain low resistance without overheating:
2. Wide metal areas in body absorb excessive heat from motor starting current and short, heavy surges:
3. Narrow cross members allow for expansion without bending:
4. Fusing points open with a minimum of arcing on short circuits.

For dependable time lag and 100% protection — specify WARE HI-LAG FUSES.

Approved by Underwriters.

Write for "LOOK INSIDE" Booklet.

WARE FUSE CORPORATION
4460 W. LAKE ST. CHICAGO 24, ILL.



You Can Forget Temperature Because Micromax Pyrometers Remember!

Micromax equipment has become a "natural" for heat-treating control because it's so completely independent of the user's attention — operates dependably, and at full sensitivity, under all plant conditions. Regardless of the product being heat-treated . . . forgings, castings, stampings or automatic screw machine work . . . a plant can take advantage of the toughness and flexibility of Micromax instruments. These features permit Micromax control to be installed where it will be the most useful . . . centralized, so that one operator can keep an eye on several furnaces, or right at the furnaces when desired.

Even if your plant does no heat treating, but uses materials or components heat-treated by suppliers, Micromax instruments in their plants can help obtain uniform high quality in your own product. Micromax control enables any heat-treater to do a better job, because he always has complete and accurate temperature information.

Our engineers are ready at all times to recommend the proper type of pyrometric equipment for any given service. Write to Leeds & Northrup Co., 4942 Stenton Avenue, Philadelphia 44, Pa.

Here Are Some Features

●Standardizing
A Micromax strip-chart instrument automatically standardizes itself.

●Ambient Temperature
A Micromax instrument compensates for all changes at the instrument.

●Supply Replacement
A Micromax instrument signals need for chart paper, ink and dry cells.

●Changes in Load
Micromax control maintains temperature in spite of fluctuations in size and weight of charge.

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*EXTREME PRESSURE

All production machinery will last longer — give better service — if the proper lubricant is used. That's why you will find it profitable to use high quality Tycol oils and greases in your plant.

There's a reason! No matter what your lubricating need — *EXTREME PRESSURE, high or low temperature, high speed or any other service condition — there's a Tycol oil or grease suited to your specific requirements.

Refined from the highest grade crudes, Tycol lubricants are exceptionally resistant to breakdown which means greater economy . . . longer machine life for every type of equipment.

Tide Water Associated will gladly recommend the Tycol lubricant that meets your particular requirements. Call, write or wire your nearest Tide Water Associated office today.

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REFINERS AND MARKETERS OF VEEDOL — THE WORLD'S MOST FAMOUS MOTOR OIL

Shipments of cold rolled sheet and strip steel increased from 3,227,000 tons in 1940 to 8,651,000 tons in 1948. In the large part that increase resulted from the use of those products by household equipment manufacturers and automobile makers. Cold rolled products are especially desirable because of their dimensional accuracy, surface finish and superior physical qualities.

Meanwhile, shipments of hot rolled sheet and strip steel rose from 7,547,000 tons in 1940 to 9,449,000 tons in 1948, a gain of 25 per cent.

At the same time, shipments of hot rolled merchant bars increased from 5,428,000 tons in 1940 to 8,124,000 tons in 1948. Shipments of cold finished bars rose from 824,000 tons in 1940 to 1,594,000 tons in 1948.

STANLEY WORKS ADDS TO COLD STRIP MILL

▲ Stanley Works at New Britain, Conn., has let a contract to the Turner Construction Co. for an addition to its cold strip rolling mill.

The one-story structure, approximately 84 by 82 ft, will have concrete foundations, brick masonry walls and structural steel framing.

TIN RESEARCH GROUP FORMS IN AMERICA

▲ The Tin Research Institute, London, England, has formed an American corporation to be called Tin Research Institute, Inc. The unit will provide free technical service to consumers of tin in the United States. The office of the new corporation, located at 492 West Sixth Ave., Columbus 1, Ohio, will in the future, handle all inquiries or requests for technical service, while a sponsorship will be maintained at Battelle Memorial Institute to handle new research.

Technical experts are available for consultation and practical assistance either at the Tin Research Institute or at the consumers' plants. Robert J. Nekervis has been appointed supervisor of metallurgical development and Robert M. MacIntosh has been appointed supervisor of chemical development in the new corporation. Both have been associated with Bat-

ARCH ROOF IS USED IN UNDERGROUND PLANT

Construction of the arch roof of the world's largest underground coal crushing plant Dravo Corp., Pittsburgh, is building for Jones & Laughlin Steel Corp. is shown above. Located about 110 ft below ground at Vestaburg, Pa., 40 miles south of Pittsburgh, the plant will serve the combined Vesta Mines No. 4 and 5. The crusher room is 33½ ft wide, 52 ft long and 78 ft deep from the crown of the arch to the conveyor pit. After passing through the crusher, coal will be carried by conveyor belt through an 800-ft long slope and over a 1000-ft suspension bridge to the new washing plant on the south side of the Monongahela River, opposite the portal. The plant is designed to process about 2000 tons of coal hourly, separating it from refuse and loading it into river barges.

To prepare steel for painting

PRE-PAINT RECOMMENDATION:
1st Stage - Spray 3
OAKITE CRYSCOAT
2nd Stage - Rinse

FOR low cost . . . for fast, thorough cleaning . . . for strong grip of paint on steel . . . for smooth, lustrous final paint coat . . . there is nothing to equal the OAKITE CrysCoat PROCESS.

FREE Write today to Oakite Products, Inc., 29 Thames St., New York 6, N. Y., for more information on the OAKITE CrysCoat PROCESS or Oakite methods for:

Precleaning in tanks or machines • Alkaline cleaning in tanks or machines • Pickling • Barrel cleaning • Electrocleaning • Steam-gun cleaning • Paint stripping • Rust prevention

OAKITE 1909 1949 40th ANNIVERSARY YEAR

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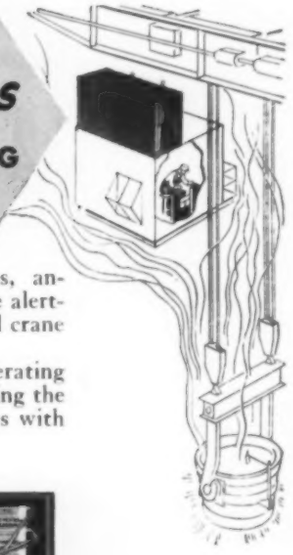
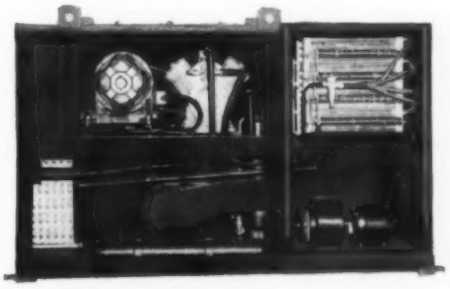
INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

DRAVO CRANE CAB COOLERS REDUCE OPERATING HAZARDS



• Excessive heat, obnoxious fumes, annoying dust and moisture reduce the alertness and efficiency of your hot-metal crane operators.
• You can eliminate these crane operating hazards by completely air conditioning the cabs on all types of hot-metal cranes with Dravo Crane Cab Coolers.



Completely self-contained Dravo Crane Cab Cooler requires electrical connection only.

DRAVO CORPORATION
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CHICAGO · DETROIT · ATLANTA · BOSTON
Sales Representatives in Principal Cities

DRAVO

telle Memorial Institute for the last 8 years, and served as assistant supervisors in the nonferrous division handling problems related to tin. The trustees of the new organization are Clarence D. Laylin, Charles E. MacQuigg, and Bruce W. Gonser, all of Columbus, Ohio.

RUST FURNACE BUILDS NEW OPEN HEARTHS

▲ Rust Furnace Co. has been awarded a contract for a new open hearth furnace and auxiliary installations to be constructed for the Granite City Steel Co., Granite City, Ill. Preliminary construction work on the $1,500,000 project started recently.

The new open hearth will have a capacity of 185 tons per heat, according to an announcement by the contractor. It will be the fourth furnace in the steel company's new shop, built during the war.

Rust Furnace Co. will construct the furnace from the foundations up. Rust will also design and build a 175 ft by 6 ft inside dimeter reinforced concrete chimney; a 25 ft extension of the furnace building's pouring bay and 250 ft of scrap car track extension. These facilities will serve the new furnace.

The steel company officials state that the new furnace will provide an additional annual ingot capacity of from 100,000 to 120,000 ingot tons. Output from the new installation will be used for carbon steel ingots.

Construction of a fourth open hearth furnace is another major step in the over-all modernization program launched by Granite City Steel Co. in 1936. This program has cost approximately $20,000,000 in construction work and equipment prior to 1949.

JOHNS-MANVILLE OPENS RESEARCH CENTER

▲ The new Johns-Manville Research Center at Manville, N. J., was dedicated on May 24 to service through science for better homes and greater industrial efficiency. Johns-Manville research has long been known for scientific accomplishment in the control of heat, cold, sound and motion and protection against fire, weather and wear. With the new research center the company has entered a new era of expanded service to homes and industry.

The four buildings of the Johns-Manville Research Center are located on a 93-acre tract on the Raritan River, about 40 miles from New York. Here, research scientists are at work on the more than 400 lines of Johns-Manville building and industrial products. In the center, activities are devoted to the improvement of existing Johns-Manville products, and the development of new products to meet new needs and demands of industry and home owners and builders.

Described as the largest laboratory facilities in the world devoted to research and development of building materials, insulations and allied industrial products, the research center embodies a completely new concept of industrial laboratory design and construction. This includes laboratories with relocatable walls and built-in services that make them as flexible as movie sets, and product development areas that include as many as 10 pilot plants under one roof in close proximity to the laboratories associated with their products.

FOR FASTER HEATING
UNIFORM TEMPERATURES
GREATER FLEXIBILITY

THE BLOOM
TEMPERED FLAME BURNER

You get more from your furnace and more from your fuel with Bloom Tempered Flame Burners! Furnace temperatures from 400° F to 2450° F can be readily maintained. This burner eliminates cold spots and hot spots, thus reducing time of annealing cycles. It assures a uniform temperature throughout the furnace chamber.

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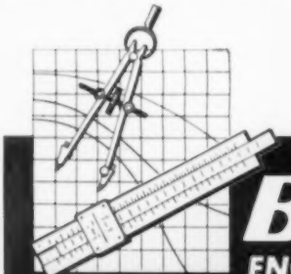
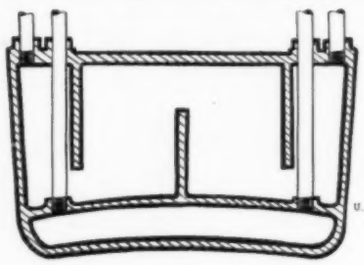


BLOOM ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 12, Pa.

A QUICK LOOK
At the Advantages of the
DOBSCHA DOUBLE COMPARTMENT COOLING PLATE



U. S. PAT. NO. 2,311,819.

A GLANCE at the accompanying illustration will reveal the two prime advantages of the Dobscha Cooling Plate:

1 The "NOSE" compartment may be sealed off, in event of "burning," without reducing the cooling area of the large volume "BUTT" compartment.

2 Direct feed and discharge affords high velocity water travel through the nose, eliminating clogging due to bad water sediment.

Get THESE "PLUS VALUES" WITH THE DOBSCHA FROM FALCON

● Falcon casts the Dobscha Plate vertically, without anchors or chaplets, "NOSE" down, so the densest metal is in the "NOSE" where needed.

Falcon installs the copper "Feed" and "Discharge" pipes to the nose compartment.

Falcon ships each Dobscha Plate in a special crate or cradle which protects these nose "Feed" and "Discharge" pipes in shipping and handling between the foundry and your furnace wall.

Falcon is licensed to make and sell the Dobscha Plate. U. S. Pat. 2,311,819.

Telephone Collect 3-4186
FALCON BRONZE CO.
YOUNGSTOWN 3, OHIO
Established 1890 • Incorporated 1895

Publication Service...

JUNE, 1949

(1) Dynamic Braking

A bulletin is available describing new, corrosion-resistant, alloy resistors, for use with Youngstown safety limit stops, to stop d-c cranehoists quickly by dynamic braking. These resistors are non-breakable and have negligible resistance-change between cold and working temperatures. (1032). Electric Controller & Manufaciurtng Co.

(2) Mobile Crane Unloads 5 Tons

A bulletin has been published describing a mobile crane that is capable of loading and unloading box cars, gondola cars, and flat cars, as well as trucks, loaded with 5-ton bundles of steel. The boom provides maximum of area between the front of the crane and underneath the boom, permitting operator to drive right up against the side of a gondola car, reaching to the far side of the car. The bulletin carries illustrations, specifications, and a drawing of over-all dimensions. (71). Silent Hoist & Crane Co.

(3) Car Shaker

Construction features, installation data and specifications on a new car shaker are presented in a bulletin just released. According to the bulletin, the new shaker speeds up the unloading of coal, cinders, ore, slag, coke and other granular materials from drop-bottom gondola cars, and eliminates danger to workmen.

The shaker, designed to fit all sizes of drop-bottom gondola cars operating in North America, consists of a heavy steel body containing a vibrating mechanism, motor and Texrope drive. Placed on the top flanges of a car by hoist or crane, the shaker transmits its vibratory motion to the car and loosens the material so it flows through the hopper openings. (07-B7221). Allis-Chalmers Mfg. Co.

(4) Excitation Control

How the VSC electronic excitation control system provides functional adaptability for production or processing operations requiring timed-rate, smooth acceleration and deceleration is concisely explained in a two-page bulletin just issued. Representing a marked advance over controls which accomplish these functions through the use of a motor-operated rheostat, this recent development is designed to provide the flexibility of electronic control and to take advantage of the economics of the rotating motor generating set as an a-c to d-c power converter in the larger horsepowers.

In addition to describing this equipment, the bulletin points out the advantages provided by the unit, ampere ratings for which it is made, a-c supply voltages for which it is available, and other interesting data. (K-2025). Reliance Electric & Engineering Co.

(5) Battery Maintenance

The availability of reprints of articles on the subject of battery maintenance is announced. Articles on the maintenance of both cycle-duty and stationary batteries are available. These articles have been reprinted in response to a large number of requests for the articles to use on battery-room bulletin boards, as instruction sheets, and as reference material. Stationary-battery reprints contain information on both installation and maintenance techniques. Illustrations, one of which is a typical stationary-type record card, are included. Cycle-duty battery reprints discuss eight primary rules of battery maintenance. Illustrations include photos demonstrating several of these rules and a reproduction of a typical cycle-duty record card. Gould Storage Battery Corp.

(6) "Where Experience Counts" . . .

. . . A story of controls for measuring and mixing both natural and manufactured gas in industrial plants is told in a recently published booklet. The booklet outlines how Cutler-Hammer, for more than 30 years has provided consistent, positive control to meet the problems of gas mixing, enriching, modifying, stabilizing, diluting and Btu measurement. The firm is known throughout the gas industry for its "Calorimeter," which provides a graphic record of the calorific value of any gaseous fuel; "Calorimixer," for accurately mixing gases; and "Thermeter" for measuring gas in small plants. Cutler-Hammer, Inc.

(7) Goggle and Bellows Valves

Just released is a new 16-page catalog section describing in considerable detail specially designed goggle valves for shutting off large diameter gas mains. The new bulletin stresses all the latest improvements and contains detail drawings. Particular emphasis has been placed on the new Brosius bellows valve, so named because it is too revolutionary in design to be termed a goggle valve, although it performs the same function. Edgar E. Brosius, Inc.

(8) Automatic Lifting Tongs

A representative assortment of automatic "Safe-T-Tongs," adapted in design and manufacture to lift and transport a wide range of materials weighing from 50 lb to 250 tons, is illustrated and described in a 22-page catalog just issued. Among the materials shown being handled by these tongs are ingots and ingot molds, barrels, coiled strip, slabs, bars, and pipe. According to the bulletin, the "Safe-T-Tongs" are fully automatic; do not require electricity or any other means of power; eliminate close work by ground crews, and each

You Can Obtain...

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

set of tongs is built to suit specific material handling needs. Included is an outline of the preliminary data required when creating a tong design. Heppenstall Co.

(9) Boiler Gas Burner

A catalog is available describing a new self-contained boiler gas burner. According to the catalog, this new burner is a package unit offering simplicity of installation to either old or new boiler settings. All combustion air is furnished through the burner by a blower which is an integral part of the burner. This gives complete fuel-air ratio control and assures the maximum heat output of any fuel used. The installation of this unit is exceedingly simple. Piping consists of only the gas line, and wiring is well marked so that the user can easily connect the few wires necessary. Mounting of the factory-assembled unit to the boiler presents no difficulty. (115). North American Manufacturing Co.

(10) Masonry Saw

Literature and detailed price information on a new masonry saw is available. According to the literature, this new saw has unusual features for fast, low-cost masonry cutting. In addition to both wet and dry cutting, instant portability, and streamlined design with rugged construction, the saw reduces the operator's first cost by enabling him to buy the saw originally equipped for standard dry cutting. He can install an inexpensive wet cutting kit in a few minutes with a screwdriver and pliers for complete dustless operation. The literature tells how the operator can, with a light upward tilt of the foot treadle, reset the cutting head at any desired angle and then press down to cut. The one-piece cutting head can be removed completely in 21 seconds from the saw frame without tools. (IS49). Eveready Briksaw Co.

(11) Corrosion Prevention

A bulletin explaining how to prevent corrosion by metallizing is available. All sorts of iron and steel equipment can be protected for many years by spraying with zinc or aluminum. No further maintenance is needed for 15 to 20 years. The booklet tells how out-door capacitors are zinc-sprayed to provide greater life and reduced replacement costs. (62.) Metallizing Engineering Co., Inc.

(12) High Silicon Iron Alloys

Available to you is a bulletin on "Duriron and Durichlor." This bulletin describes a corrosion resistant alloy which shows unexcelled corrosion resistance to such acids as sulphuric, nitric, hydrochloric, acetic and most other mineral and organic acids. The principal exceptions are hydrofluoric, sulphurous and hydrofluosilicic. This resistance is not appreciably affected by either concentration or temperature. (113). Duriron Co.

(13) Radioactive Tracers

A bibliography on the industrial uses of radioactive tracers is available without charge. Arthur D. Little, Inc.

(14) Roll Turning Lathe

A group of performance reports are available to you on a new, specially-designed lathe equipped with electrically contouring controls. This new lathe is said to slash machining time on chilling cast iron rolls by more than two-thirds of the past current practice. All rolling mill men concerned with roll turning should have these performance reports in their files. Monarch Machine Tool Co.

(15) Double Tension Locknut

A very complete catalog is available to you describing the new "Dualock Double Tension Locknut." The development of this locknut is one of the significant contributions which wartime ingenuity has made to the problems of peacetime production. Since the war, this locknut has been introduced to industry in general and has received widespread acceptance in many and varied fields of manufacture. This precision-made fastener is fabricated from high quality steel and is of one piece construction. The locknut is easy to put on and to take off. It can be used any number of times. Dualock Products.

(16) Corrosion Control

Literature is available to you on the use of magnesium anodes for cathodically protecting pipe lines and other material structures. The electrical ratings, weights, sizes and forms of the various anodes are included, together with a price schedule. The materials described in this literature have become widely recognized as an efficient, economical means of controlling corrosion of pipe lines, tanks, operating equipment, steel piling, cables and many other structures in contact with earth or water. Dowell, Inc.

(17) Hot Metal Cars and Ladles

A folder is available describing hot metal ladles and cars for blast furnaces and steel plants. It discusses the new Kling type ladle and compares it with the conventional type ladle. It tells how the ladles can be made for either long pouring or for short pouring. Also discussed is the elimination of the intermediate transfer ladle which saves operation and maintenance costs as well as a considerable amount of heat in the material. A list of these ladles and ones now in service with the capacities of each are also given. William B. Pollock Co.

(18) Single Phase Motors

A catalog is available on the repulsion start induction single-phase motor which has starting and operating advantages not obtainable from other types of single phase motors. According to the catalog, these motors combine the starting characteristics of a repulsion motor with the running characteristics of an induction motor, resulting in starting and operating advantages. Cutaway views as well as charts and tabular information are included. (Form 942). Century Electric Co.

(19) One-Man Material Mover

A bulletin is available describing a one-man, self-propelled mounting for all makes of cranes from 10-25 ton capacity. This mount is known as the "Keystone Krane Karriage." Propulsion power is obtained through the travel clutches and vertical travel shaft of the crane. The unit is equipped with a four-speed transmission with a speed range of 2 to 10 mph in either direction. These units are available as new and original equipment or may be obtained to convert crawler or rail type cranes to rubber tired

mountings. Equipment Div., Keystone Driller Co.

(20) Tube Cleaners

A bulletin is available on air or water driven tube cleaners for small tubes, straight or curved. The leaflet illustrates disassembled views of motors, circular and expanding brushes, cutter and scraper heads. A size tabulation is included. Lagonda Div., Elliott Co.

(21) "Corrosion-Resistant Piping Materials" . . .

. . . is the title of a booklet which is available to you. This booklet contains descriptions and information on the complete crane line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. The booklet also contains eight pages of condensed recommendations, description of alloy materials, and corrosion questionnaire. (320). Crane Co.

(22) Acid Resisting Paint

Issuance of a new technical information bulletin and data sheet on "Chem-Rem," acid and alkali-resisting paint, is announced. The bulletin lists typical applications and describes paint features in detail. "Chem-Rem" is a black industrial paint which withstands attacks of acetic and hydrochloric acids, dilute sulphuric acids or mixtures of these acids. It protects against the severe action of bleaching solutions, dilute caustic soda, ammonia or other alkalines and is reputed to greatly increase the effective life of buildings and equipment. Speco, Inc.

(23) Instrument Catalog

The complete line of Speedomax instruments . . . indicators, indicating recorders, and recording controllers . . . is described and illustrated for the first time in a new 44-page catalog. Called "Speedomax Type G Instruments," the publication describes these high-speed, high-sensitivity instruments for all the uses for which they are now available. The pyrometers listed are supplied for measuring temperature with thermocouples, Rayotubes or Thermohms. Other instruments listed are those for recording speed and load. Illustrations in the catalog include: close-ups showing design features; schematic diagrams of the Speedomax potentiometer and Wheatstone bridge circuit; and full-size, full-color sections of a round chart and a strip-chart, with the type of record available for each. (ND46-1). Leeds and Northrup Co.

(24) Motoreducer

Two new bulletins are available describing a new line of all-steel "Motoreducers" which represent the culmination of an exhaustive ten-year program of research, design and test studies. This new all-steel "motoreducer" retains all of the time-tested design features which characterized the original placed on the market for the first time over 16 years ago. Many additional improvements have been added to the new all-steel unit that contribute materially to its appearance and efficiency. The complete line includes horizontal and vertical units in both integral and all-motor types, for floor, wall or ceiling mount. The basic "motoreducer" unit can be converted to right angle, V-Belt, multi-speed, low ratio, ceiling mount and many other adaptations. Advantages, features, selection tables, weights, dimensions, etc. are listed in these bulletins. Falk Corporation.

(25) Indicating Recorder and Controllers

In a 32-page illustrated catalog just issued, Leeds & Northrup lists for the first time in one publication, their complete line of strip-chart Micromax recorders and controllers for measuring a wide variety of process variables . . . temperature, speed, gas analysis, electrolytic conductivity, pH, etc. Called, "Micromax Model S — Indicating Recorder and Controllers," this publication gives complete specifications in convenient, tabular form. Among the indicating recorders are single-point, two-point and multiple-point instruments which measure the values detected by one or as many as 16 primary elements. Among the recording controllers are those which provide two-position control or are integral parts of full proportional control system . . . the latter either Micromax electric control — position-adjusting type for regulating valves, vanes or dampers; duration-adjusting type, primarily for electrically-heated units — or Micromax pneumatic control for air-actuated valves. (ND44-1). Leeds & Northrup Co.

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PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ALLIS-CHALMERS MANUFACTURING CO.	BULLETIN 18B6760	Complete story on Allis-Chalmers Air Blast Metal-Clad Switchgear.
51	ASKANIA REGULATOR CO.	BULLETIN 138-A	Askania Electronic System for operating valves, throttles, machines, variable drives up to 1000 ft away.
52	BABCOCK AND WILCOX CO., REFRACTORIES DIVISION.	BULLETIN 3-412	Provides facts and figures which will help you achieve significant savings by reducing costs of furnace operation.
53	BAILEY METER CO.	BULLETIN 211	Bailey Smoke Density Recorder.
54	BEDFORD FOUNDRY AND MACHINE CO.		Catalog describing cranes having capacities from 5 to 150 tons.
55	BROWNING AND CO., INC., VICTOR R.	BULLETIN S	Describes Browning mill type cranes.
56	CLARK CONTROLLER CO.	BULLETINS 7313 V-T AND 7400	Complete details on "Vari-Time" relays and cores for d-c control.
57	CLEVELAND WORM AND GEAR CO.	CATALOG 300	Full description of "Speedaire," a new fan-cooled worm-gear speed reducer.
58	COLUMBIA ELECTRIC MANUFACTURING CO.	CATALOG IS-700	Describes motor generators for electroplating and electro-cleaning.
59	DURABLA MANUFACTURING CO.	BULLETIN 9S6	Describes a pump valve that grinds itself.
60	ELECTRIC CONTROLLER AND MANUFACTURING CO.	BULLETIN 942	Describes the "Tab-Weld" plate resistors.
61	ELECTRIC STORAGE BATTERY CO.		Copy of Exide-Ironclad Topics, which contains latest developments in materials handling and shows actual case history.
62	GENERAL ELECTRIC CO.	BULLETIN GEA-4654	Technical data on the MD-600 mill motor.
63	HOMESTEAD VALVE MANUFACTURING CO.	REFERENCE BOOK 39. — SECTION 5	Shows sizes, types and pressure ratings for Homestead-Reiser lubricated plug valves.
64	INTERNATIONAL GRAPHITE AND ELECTRODE CORP.		Booklet containing graphite engineering data.
65	KLING BROTHERS ENGINEERING WORKS.	BULLETIN 245	Gives specific facts and specifications on Kling rotary shears.
66	NATIONAL BEARING DIVISION, AMERICAN BRAKE SHOE CO.		Complete data on N-B-M Babbitt metals.
67	NEW YORK AND NEW JERSEY LUBRICANT CO.	BULLETIN 506AISE	The bulletin describes "Non-Fluid" oil for lubricating ball and roller bearings. A testing sample will be included.
68	PENNSYLVANIA TRANSFORMER CO.	CATALOG 349	Describes, in detail, the new "Pole Star" transformer.
69	POOLE FOUNDRY AND MACHINE CO.		Catalog giving full description and engineering data sent upon request.
70	PYLE-NATIONAL CO.	CATALOG 1100	Vaportight lighting Pylets.
71	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN B-2101	Detailed performance data on Reliance Precision Built Motors.
72	TIDE WATER ASSOCIATED OIL CO.		"Tide Water Associated Lubricania," gives clear, concise descriptions of the basic tests to determine properties of oils and greases.
73	WAGNER ELECTRIC CORP.	BULLETIN TU-181	Information on the complete line of Wagner Power Transformers.
74	WALDRON CORP., JOHN	CATALOG 57	Gives design details, ratings, service factors on gear type couplings.
75	WARE FUSE CORP.		"Look Inside" which describes Ware "Hi-Lag" renewable fuses.
76	WESTINGHOUSE ELECTRIC CORP.	BULLETIN B-3998 BOOK B-3776	"Rototrol in the Steel Industry." Describes the uses and advantages of "Micarta" roll-neck bearings.
77	YOUNGSTOWN WELDING AND ENGINEERING CO.		Descriptive literature on the "Weldco" mechanical pickler.

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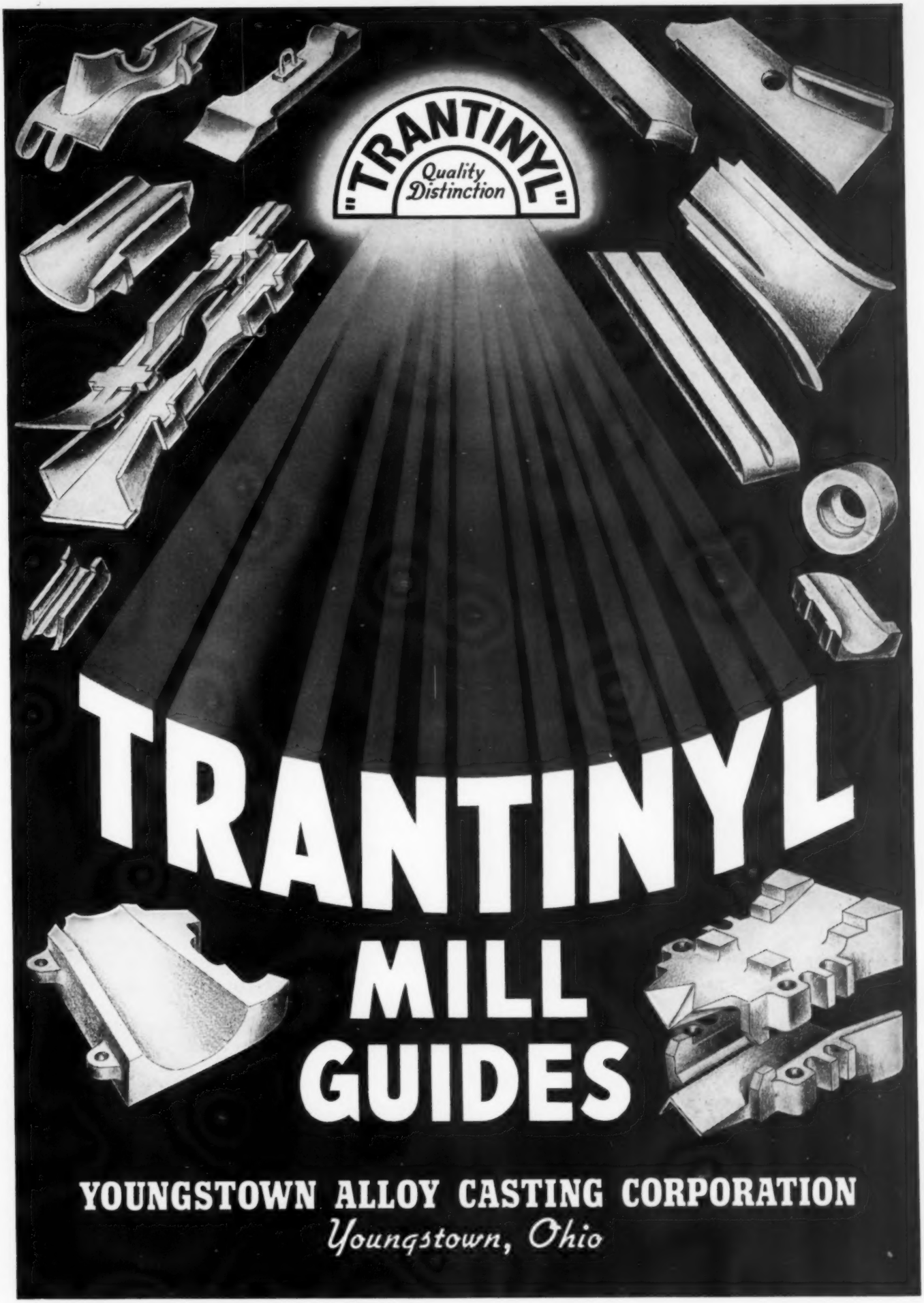
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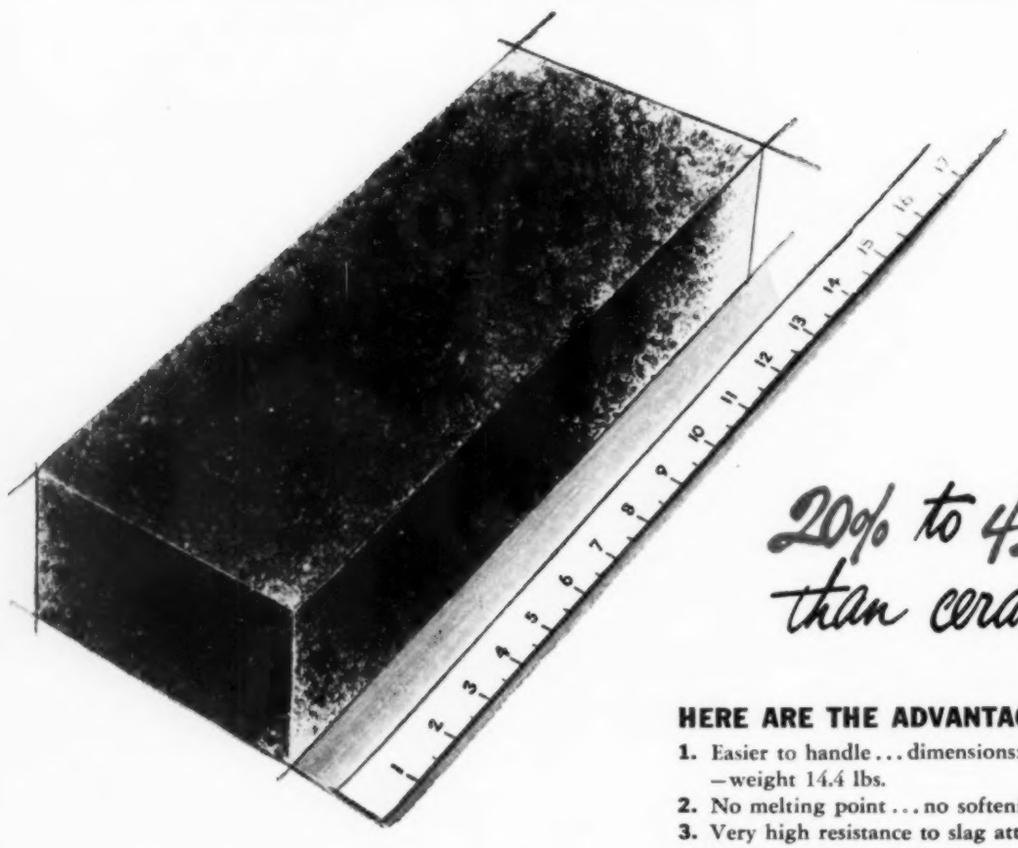

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5. Fewer joints to cement—a faster, sounder job
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OTHER NEW BRICK SIZES:

Key brick 13½" x (6"-5") x 3"—weight 13.2 lbs.
Straight brick 9" x 6" x 3"—weight 9.5 lbs.
Key brick 9" x (6"—5⅛") x 3"—weight 9.1 lbs.

For more information, write to National Carbon Co., Inc., Dept. 15

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***Weights in lbs. per cubic foot of carbon vs. ceramic brick: Carbon—96. Firebrick—120-130. Acid-proof brick—148. Chrome brick—175-180.**

Personnel News...

Harry A. Fohl has been named chief engineer of Lukens Steel Co., Coatesville, Pa.; **Neils H. Jensen** has been named assistant chief engineer and **Malcolm B. Antrim** has been appointed as superintendent of electrical maintenance. **P. C. Haldeman,** who has been chief engineer since April 9, 1932, and **Walter H. Burr,** who has been superintendent of electrical maintenance since December 1, 1921, will both retire on July 1, each having reached the age of 70 years. Mr. Fohl who has been assistant to the chief engineer formerly had been master mechanic. Mr. Jensen, who had been plant engineer with By-Products Steel Co. and Lukenweld, divisions of Lukens, formerly had been assistant to the chief engineer and Mr. Antrim had been assistant superintendent of electrical maintenance.

Mr. Fohl, who was born in Cleveland, Ohio, was graduated from Franklin and Marshall and has had many years experience with Lukens in engineering and mechanical maintenance.

Mr. Jensen, who was born in Denmark, holds a Master's degree from the Royal Engineering College of the University of Copenhagen. He has been engaged in Lukens engineering activities since 1940.

Mr. Antrim, who was born in West Pittston, Pa., was graduated from Renssalaer Polytechnic Institute with a degree in electrical engineering. He has been associated with the electrical department of Lukens since September 18, 1941, where he has been senior technical engineer, and assistant to the superintendent, and since December, 1948, assistant superintendent of electrical maintenance.

Mr. Haldeman, a native of Westfield, Mass., and a graduate of Pennsylvania State College, has been associated with Lukens since 1901, except for a brief interlude in 1905. He has been master mechanic and chief consulting engineer, and since 1932, chief engineer.

Mr. Burr, who was born in Unionville, Ill., was graduated from Rose Polytechnic Institute with a B.S. degree in electrical engineering. He joined Lukens in 1921 as superintendent in the electrical department, in which position he has served continuously since that time.

G. A. Lorz has been named superintendent of operations at the Garrison plant of Mackintosh-Hemphill Co., Pittsburgh, Pa. **C. R. Hodgson** has been made superintendent of operations at the company's plant at Midland, Pa.

Jack M. Lutz has been appointed assistant to the president of Continental Foundry & Machine Co. Mr. Lutz has for many years been engaged in steel industry sales. His headquarters will be in East Chicago, Ind.

Karl T. Davis was appointed eastern manager, industrial department of American Arch Co., Inc. Mr. Davis is a graduate of Carnegie Institute of Technology and has been in the industrial furnace business for more than twenty years.

Rear Admiral Clinton E. Braine, USN (Ret.), has joined Crucible Steel Co. of America as assistant to the president. Admiral Braine comes to Crucible following his retirement from the Navy. He most recently was Assistant Chief of Naval Materiel, for Production, in Washington, D. C.

William F. Zerbe has been named vice president in charge of operations of Central Iron and Steel Co., Harrisburg, Pa., subsidiary of Barium Steel Corp. Announcement of Mr. Zerbe's new designation was simultaneous with creation of the vice presidency. He will be succeeded as general manager of plant operations by **H. M. Jones,** his former assistant. Mr. Zerbe has been affiliated with Central in production and executive capacities for 38 years.

Irvin W. Gray, who had previously served as superintendent of the 98-in. cold mill, has been named assistant electrical superintendent, Cleveland district, for the 98-in. strip mill, Republic Steel Corp. Mr. Gray joined Republic in 1937. **Benjamin T. Beasley, Jr.,** who had previously been a Civil Service employee of the U. S. Navy, has been named assistant electrical superintendent for the steel plant, other than the 98-in. mill.

Tom C. Ingersoll has been appointed general manager of the Pacific coast district for Bethlehem Pacific Steel Corp., shipbuilding division, including the San Francisco, Alameda, Calif., and San Pedro, Calif., yards. Mr. Ingersoll continues to serve as manager of the San

HARRY A. FOHL

NEILS H. JENSEN

MALCOLM B. ANTRIM

WALTER H. BURR

DE LAVAL VERTICAL DRIVE REDUCERS

A complete line of De Laval vertical speed reducers, in both single and double reductions, is available for driving agitators, mixers, and many other types of vertical shaft equipment.

If vertical drives are your problem, consult De Laval.

*This single reduction De Laval Worm Gear Reducer is available with many standard gear ratios and is but one of the 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

*ONE OF 93

WG-16

Worm Gear Division

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TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS
CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

Francisco yard, a position he has held since 1944. He succeeds **W. M. Laughton,** who has retired as general manager of the Pacific coast district, but continues to serve in a consulting capacity.

C. E. Owen has been elected chairman of the board of Lone Star Steel Co., Dallas, and **W. O. Irvin** has been elected to fill a vacancy on the board created by the resignation of **R. W. Wortham.**

Frank V. Carroll has been appointed consulting engineer of Inland Steel Co. He will be in the company's

FRANK V. CARROLL

Chicago offices, moving up from his position of chief engineer of the firm's Indiana Harbor, Ind., works.

J. P. Williams, Jr., chairman of the board of directors of Koppers Co., Inc., Pittsburgh, Pa., has retired from the active management of the company.

Eads Johnson, Jr. has been appointed assistant vice

EADS JOHNSON, JR.

president of the Southern Wheel division of the American Brake Shoe Co., New York, N. Y.

George A. Burgermaster and **C. Russell Todd** were appointed assistant purchasing agents for Hyatt Bearings division of General Motors Corp. **William E. Jones,** assistant purchasing agent since 1925, has retired which created one of the vacancies. The other was occasioned by the recent promotion of **Leo V. Farrell** from assistant purchasing agent to general purchasing agent, the position formerly held by **Frank A. Weiss,** now assistant to the general manager.

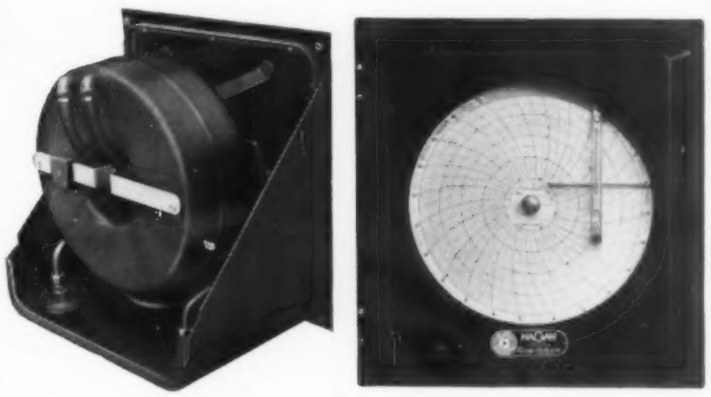
Sensitive...accurate...reliable

Hagan Ring Balance Draft Gage

The basic principle of the Hagan Draft Gage is the same as that of the Hagan Ring Balance Flow Meter. It is a radial torque device which uses a hollow ring body to convert difference in static pressure into a rotation which is transmitted to recorder or indicator. The ring body is partially filled with a sealing fluid, and is divided into two compartments by means of a baffle in the upper part of the ring.

As in the Flow Meter, there is an opening in the ring on each side of the baffle. One of these openings is connected to the pressure to be measured; the other is open to the atmosphere. The difference between this pressure and the pressure of the atmosphere — whether positive or negative — causes rotation of the ring body. The ring moves through an arc of 15°, with a radius of 5 to 5½ inches, thus giving far greater total movement than any other type of draft gage.

The ring assembly is mounted on a knife-edge bearing. This mounting, plus the fact that there are no stuffing boxes, virtually eliminates friction. There is no diaphragm to dry out, no bellows to crack or corrode. Unexpected pressure rises do not damage the gage or affect its accuracy. At the most, a sudden high pressure will do no more than drive the sealing fluid from the ring body, and as soon as the fluid is replaced the gage is again ready for use.



For full information on Hagan Ring Balance Draft Gage, fill in the coupon below or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

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Hagan Building
Pittsburgh 30, Pa.

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Company_____

Position_____

Street_____

City_____ State_____

ISE-6

Especially designed for high speed, high production shearing. Will handle flat and round mild steel bars in addition to structural and bar angles. Round bars and bar angles are sheared on the left side, while the right side is used for structural angles and flat bars.

These special shears are equipped with automatic hold downs and "Y" type roller supports, also a removable guide for flat bar shearing. Recommended for straight shearing only. Mitreing can be accomplished by removal of holddowns. Available in four sizes.

Write today for full particulars.

Kling BROS. ENGINEERING WORKS

Manufacturers of Rotary, Plate Bar Shears Combination Shears, Punches and Copers, Single and Double End Punches, Angle, Beam, Bar and Plate Benders High Speed Friction Saws.

1344-IS NORTH KOSTNER AVENUE CHICAGO 51, ILLINOIS

Grover J. Meyer has been named president and director of Lombard Corp., Mr. Meyer succeeds **D. L. Lombard**, who is now chairman of the board of directors.

H. P. Rees has been named general superintendent of the newly-combined Farrell and Lowellville plants of Sharon Steel Corp., Sharon, Pa. Mr. Rees has served as general works manager for the past 12 years. **William J. McGaffney** has been appointed assistant general superintendent. Mr. McGaffney has for the last two years been assistant general works manager at the Lowell plant. **J. T. Bachman,** assistant operating vice president for the past four years, has been transferred to the sales department of the company. **F. B. Quigley,** general superintendent of the Farrell works, has been appointed consultant to the operating management.

F. M. Rich, vice president in charge of operations, Kaiser Co., Inc., and formerly located in Fontana, Calif., has been transferred to the Oakland, Calif., home office of the company. **George B. McMeans,** general superintendent, has been placed in charge of Fontana.

David P. Anderson was appointed chief engineer of the Duquesne, Pa., works of Carnegie-Illinois Steel

DAVID P. ANDERSON

Corp. Mr. Anderson has served in various engineering capacities at the Duquesne works since 1907.

H. E. Heywood, Jr. has been appointed assistant chief engineer of the Toledo, Ohio, plant of National Supply Co.

F. W. Bremmer has been appointed vice president in charge of manufacturing, National Supply Co., Pittsburgh, succeeding **Charles R. Barton,** who has retired. Mr. Bremmer had formerly been works manager of the Ambridge plant of the Spang-Chalfant division.

Frank B. Moran has been appointed superintendent of industrial relations of the Etna, Pa., plant of Spang-Chalfant division of National Supply Co., Pittsburgh. **A. D. Cadenhead** has been appointed supervisor of the newly-formed community relations department.

Appointment of additional field sales application engineers to ten of the company's 38 sales offices was announced by Reliance Electric & Engineering Co., Cleveland, Ohio. The men, most of them recent graduates of leading engineering colleges, have received intensive training in the company's engineering, manu-

ONLY PROPER COMPOUNDING AND FRICTIONING GIVE *Longest-Lived* SPLICING TAPES

Okonite Rubber and Manson Friction Tapes provide every essential characteristic

For over 60 years, electrical men who want the best have specified Okonite Rubber and Manson Friction Tapes. With today's emphasis on lasting values, these tapes are more important than ever.

Properly compounded from Up-River Fine Para rubber, Okonite Tapes fuse into a homogeneous wall of tough insulation, high in dielectric strength, elastic, resilient and permanently waterproof.

In Manson Friction Tapes, new, naturally tacky rubber has been properly frictioned into a closely-woven fabric to give the true adhesiveness plus the aging and weathering qualities needed for lasting protection of the insulating compound.

with today's high installation costs* only the *Longest-Lived* splices will be economical

* The lifetime cost of an electrical splice is more important — and more economical in the long run — than the first cost of the tape that makes it. Okonite and Manson Tapes are built to deliver maximum value when you consider (1) seriousness of a failure and (2) doubled installation cost when splice has to be rebuilt.

FOR ELECTRICAL MEN IN INDUSTRIAL PLANTS

Okonite and Manson Tapes are widely used in many kinds of field work. Whether for splicing underground cable, risers or overhead lines, Okonite and Manson Tapes offer not only long service life but also ease of handling and splicing — with resulting lower application costs.

Let us send you a ½-pound trial can of each of these tapes — free — enough to make a dozen or more splices in #6 wire. See for yourself how much better jobs you get. Just make the request on your business letterhead. The Okonite Company, 19 Canal Street, Passaic, N. J.

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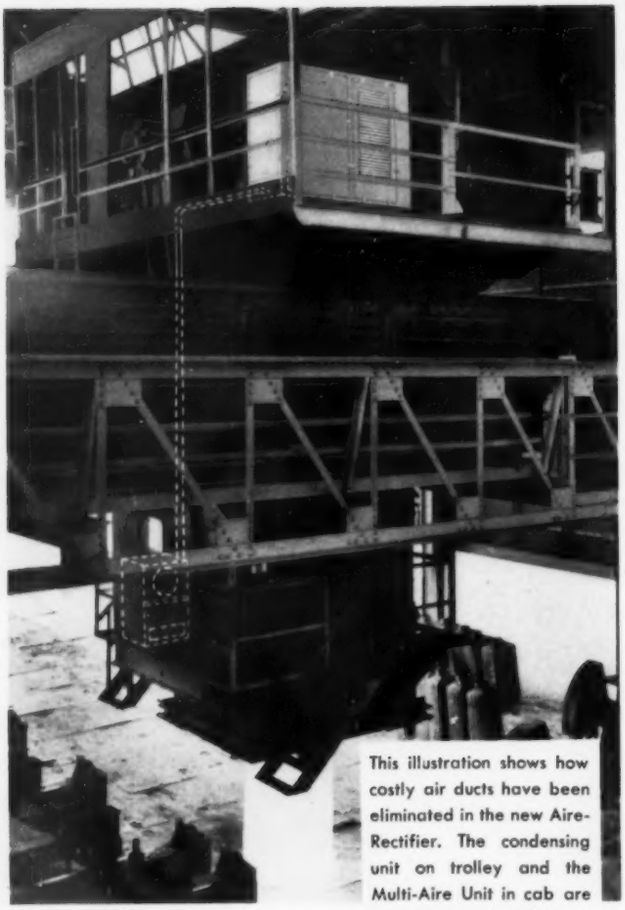
OKONITE (OKONITE SINCE 1878) **and MANSON TAPES**

THE BEST TAPE IS YOUR BEST POLICY



This illustration shows how costly air ducts have been eliminated in the new Aire-Rectifier. The condensing unit on trolley and the Multi-Aire Unit in cab are connected with **refrigerant lines.**

This New Lintern Aire-Rectifier

Has Demonstrated Its Efficiency and Savings

Proven in actual operating service for the past two years on cranes in a prominent mill in the Chicago district, this new Aire-Rectifier has unquestionably demonstrated its efficiency and savings:

(1) Reduced engineering costs. (2) Elimination of expensive, efficiency-reducing air ducts. (3) Higher cooling efficiency in the cab. (4) Greater Flexibility in location of all equipment. (5) Lengthened life of operating equipment because of protection from excessive radiant heat and greater accessibility for service. (6) Location of Aire-Rectifier on existing cranes without moving any equipment.

We accept full responsibility for successful operation when instructions are followed. Savings of $1,000 to $2,500 per installation are being made. May we send you full details applicable to your situation?

THE LINTERN CORPORATION

54 LINCOLN AVENUE • BEREA, OHIO

facturing and sales departments. Their names and their new field assignments follow: **Byron O. Lutman** to Detroit; **Robert C. Suttle** to Cincinnati; **William H. Chambers** to Syracuse; **Robert L. Potter** to Pittsburgh; **William B. Maley** to New York; **Eugene H. Sowers** to Philadelphia; **J. Robert Zahn** to Cleveland; **Robert Magnetti** to Chicago; and **Robert B. Reed** to Birmingham, Ala. Two other appointments of importance were announced. **Clyde F. Giegel,** who has served Reliance in a number of capacities over a period of several years, joins the Pittsburgh office as a field service engineer. **Albert M. Cherry,** who for the past two years has been in the company's general sales offices in Cleveland, moves to the Rockford, Ill., sales office.

James R. Shepard has been appointed western district works manager in Chicago, Ill., and **Thomas J.**

JAMES R. SHEPARD

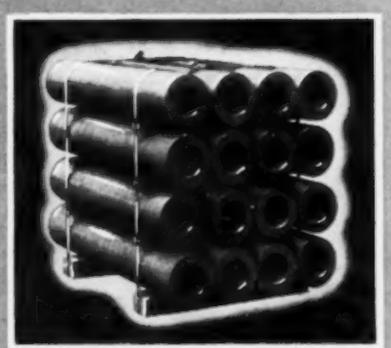
THOMAS J. WOOD

Wood has been appointed eastern district works manager of the Brake Shoe & Castings division of the American Brake Shoe Co. in New York, N. Y.

Donald C. Sheldon has been elected assistant treasurer and **Kenneth A. Anderson** has been elected assistant secretary of the American Brake Shoe Co., New York, N. Y.

Gilfry Ward has been appointed vice president in charge of sales of the American Manganese Steel divi-

BOUND TO CUT ELECTRODE COSTS....



International graphite electrodes, sizes up to 20" x 72", are bundled on pallets, bound with steel straps for fast, easy handling by crane or fork lift. As a result, unloading time is cut, storage space is cut . . . your overall electrode costs diminish substantially.

Palletizing electrodes is just one of many ways International helps cut your costs . . . one reason why you can profit by calling on International to supply your electrode requirements. Send for free booklet on graphite engineering data.

Graphite products for electrothermic and electrolytic applications

International **GRAPHITE AND ELECTRODE CORP.**

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Want to prolong the life of Ball and Roller Bearings?

LUBRICATE WITH

NON-FLUID OIL

TRADE MARK REGISTERED

The ideal lubricant for ball and roller bearings must be strictly neutral and free from any tendency to develop fatty acids which corrode and pit the bearings.

NON-FLUID OIL meets the strictest tests of bearing engineers. It will not decompose or become acid to pit or corrode the highly polished steel surfaces.

NON-FLUID OILS provide dependable lubrication over the widest temperature range and outlasts ordinary greases many times — assuring worthwhile savings in lubricant and application cost.

Write for Bulletin 506 AISE and free testing sample of NON-FLUID OIL.

NEW YORK & NEW JERSEY LUBRICANT CO.

292 MADISON AVENUE NEW YORK 17, N. Y.
WAREHOUSES: Charlotte, N. C. — Greenville, S. C. — Atlanta, Ga. — Providence, R. I. — Detroit, Mich. — Chicago, Ill. — St Louis, Mo.
WORKS: Newark, N. J.

NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture.

sion of the American Brake Shoe Co., Chicago Heights, Ill.

J. G. Schaefer has been named manager of Allis-Chalmers newly converted Youngstown, Ohio, district office. Formerly a branch office, it has been moved from the Mahoning Bank Building to the Ohio Edison Building. The new district office will cover Trumbull, Mahoning and Columbiana counties in Ohio, and Lawrence, Mercer, Venango, Crawford, Erie, Warren and McKean counties in Pennsylvania.

Duncan S. Cameron has been appointed open hearth superintendent, Wickwire Spencer Steel division, Colorado Fuel & Iron Corp., Buffalo, N. Y. Mr. Cameron has been associated with Pacific States Steel Co., the Kaiser Co. and Republic Steel Corp. **Carl J. Murray** has been named plant manager at the Buffalo works. Mr. Murray had previously been connected with the Jessop Steel Co. as general superintendent and had previously been plant engineer with Crucible Steel Co. of America.

W. F. Rauber has been appointed manager of sales for the switchgear division, apparatus department, General Electric Co., at Philadelphia, Pa.

James H. Goss was appointed manager of engineering in the control divisions of General Electric's apparatus department.

James L. Crawford, former vice president and general manager of Walsh Refractories Corp., St. Louis, Mo., was elected president. **N. S. C. Walsh,** retiring president, was named honorary board chairman.

J. D. Greensward was named general manager of the Norwood, Ohio, works of Allis-Chalmers Manufacturing Co. Mr. Greensward succeeds **Frank H. Stohr,** who died in March.

The following new officers of Lintern Corp., Berea, Ohio, were elected: **James W. Lintern,** executive vice president; **J. N. H. Christman, Jr.,** vice president in charge of engineering; **Ted Ley,** vice president in charge of production; **F. T. Siersma,** vice president; **Edward Warnoski,** assitant treasurer and auditor; **John C. Lintern,** secretary. **Wm. Allan Lintern** continues as president and treasurer.

W. Kenneth Scott was appointed electrical engineer for Columbia Steel Co. with headquarters in Oakland, Calif. During his twenty-five years with Columbia, Mr. Scott served in several construction and maintenance capacities; the most recent as assistant superintendent of construction for Columbia's cold-reduced sheet and tin plate project at Pittsburg, Calif.

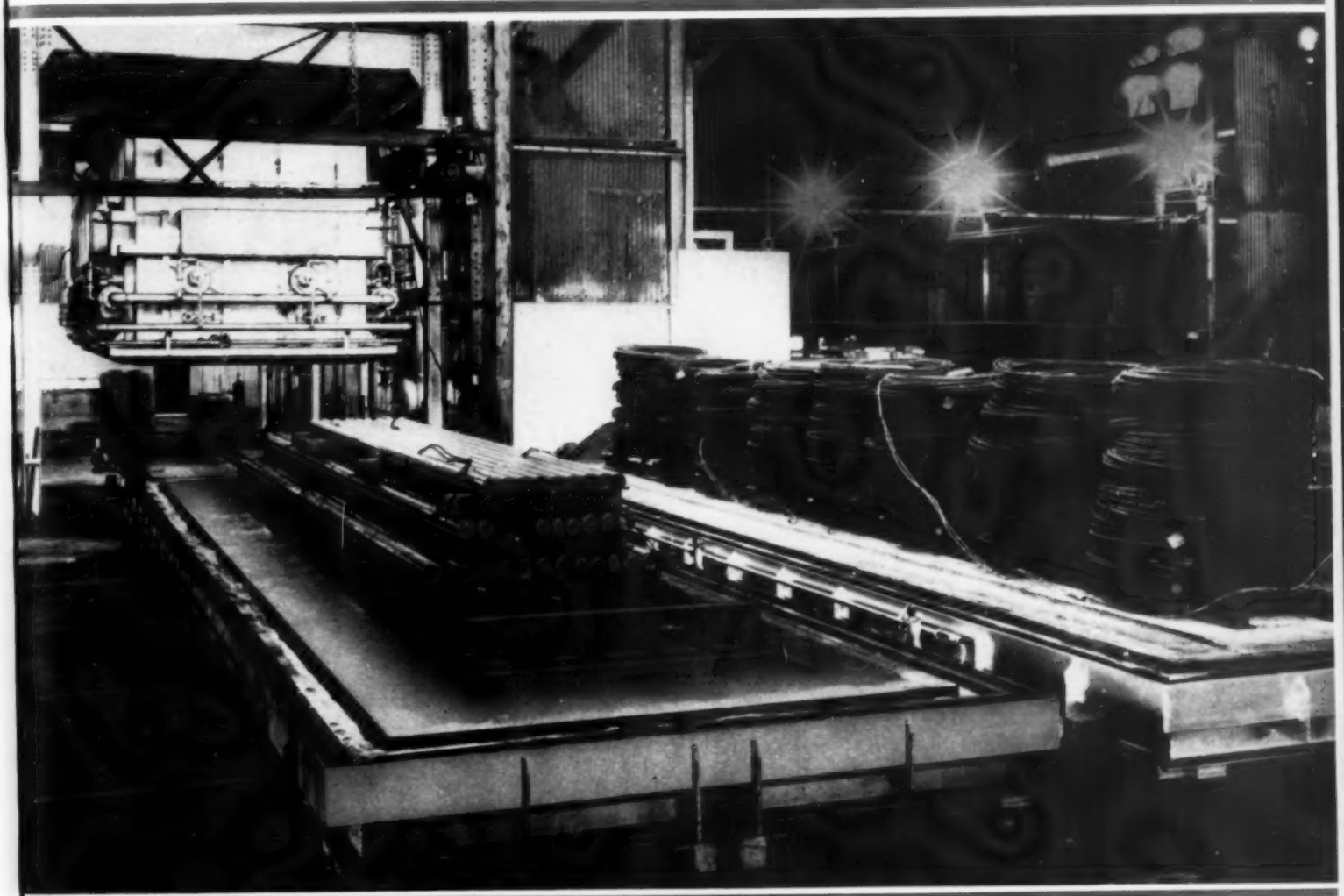
D. L. Kuhner, superintendent of the Portsmouth, Ohio, works of Harbison-Walker Refractories Co., has been appointed superintendent of the company works at Olive Hill, Ky. **R. H. Cook** was named superintendent of the Portsmouth works.

Frank B. Moran has been appointed superintendent of industrial relations of the Etna, Pa., plant of Spang-Chalfant division of the National Supply Co. Previous to this appointment, Mr. Moran had served in the same department as assistant superintendent.

Frank J. Wood has been named chief plant engineer of the fabricating division of Permanente Metals Corp.,

Lamellar Annealing Combined with CARBON RESTORATION *for Straight or Coiled Merchant Bar*

This Wilson Annealing Unit was installed at the Wyckoff Steel Company, Ambridge, Penna.



LEE WILSON ENGINEERING COMPANY, INC.
INDUSTRIAL FURNACES
RADIANT TUBE HEATING
HEAT TREATING PROCESSES

20005 WEST LAKE ROAD
CLEVELAND, OHIO
ACADEMY 4670

THIS installation of a Wilson rectangular bell type annealing furnace at the Wyckoff Steel Co. at Ambridge, Pennsylvania, combines lamellar annealing with the process of carbon restoration for either straight or coiled merchant bar. Maximum bar length — 30 feet. The entire installation including hoisting equipment, and nitrogen carrier gas plant was engineered by the Lee Wilson Engineering Company, Inc. The features of design which make this installation particularly successful include a *completely gas tight* furnace with *radiant tube* heating, and an *OIL* seal between the furnace and base.

Oakland, Calif. Mr. Wood was formerly manager of the Loewy Construction Co., rolling mill division of Hydropress, Inc.

Obituaries

Dana J. Fox, 60, president and treasurer of the Fretz-Moon Tube Co., Butler, Pa., died May 9.

William T. Mossman, former publicity and advertising manager of Jones & Laughlin Steel Corp., died early May 5. Mr. Mossman had been retired from J&L since September 30, 1947. "Bill" Mossman was born in Tidioute, Pa., May 3, 1873. Mr. Mossman worked his way through Allegheny College by giving art lessons and surveying, and was graduated in 1895. He studied law for a year in Mercer, and decided to come to Pittsburgh to seek his fortune.

Talented as an artist and writer, he got a job in 1896 on the old "Pittsburgh Leader," an afternoon paper. He left to become editor for the old "Bulletin Index." In 1905 he was named manager of the Pittsburgh Symphony Orchestra.

Mr. Mossman left the orchestra in 1907 to handle press relations for J&L. Press relations later grew into the publicity and advertising department. He continued in this capacity for forty years until his retirement.

Plan to attend . . . .

ANNUAL CONVENTION

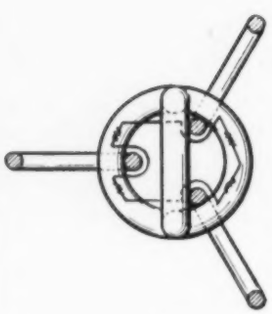
ASSOCIATION OF IRON AND STEEL ENGINEERS

PITTSBURGH, PENNSYLVANIA

HOTEL WILLIAM PENN

OCTOBER 3, 4, 5 AND 6, 1949

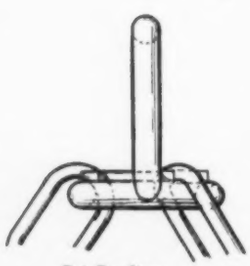
...LONG LASTING MAGNET CHAINS



Heat-treated high alloy steel PLUS the patented ring to eliminate rubbing and twisting gives Downtown Frictionless Magnet Suspension Chains up to 3 times the life of old-style suspension chains.

Locating Plate keeps magnet face level.

No more periodic annealing.



Pat. Pending

For these reasons Downtown Suspension Chains offer you best dollar value.

Each chain for 55 inch magnets is tested to 89,000 lbs. Each chain for 65 inch magnets is tested to 115,000 lbs. Don't delay! Write now for prices. Prompt shipment from stock.

DOWNTOWN *Company*

1836 EUCLID AVE. • CLEVELAND 15, OHIO

CRANE BUILDERS Since 1903

BEDFORD CRANES

Capacities 5 to 150 Tons

Designed and Engineered to Meet Your Requirements

Any Span or Lift
Send For Your
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ELECTRIC OVERHEAD TRAVELING CRANES
GANTRY CRANES • STEEL DERRICKS
BUILT TO YOUR SPECIFICATIONS
STRUCTURAL STEEL • STEEL BUILDINGS

BEDFORD FOUNDRY & MACHINE CO.

Engineers
Designers
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BEDFORD, INDIANA
U. S. A.

Gray
Iron
Castings

COMPLETE ENGINEERING Survey of Large Sewers Requires—More Pictures

This photo shows the outlet of the sewer. Note that bricks are missing from the invert of the sewer and the mortar has disintegrated in the coping.

Note in this picture particularly the settlement of the earth approximately 50 feet from the outlet. This is probably caused by a leakage from the sewer.

The results of the inspection, study and many photographs of the interior condition and construction of the sewer indicate a deterioration of the structural components materially weakening it. This, and the importance of this particular sewer led to the recommendation for the immediate consideration of a new and larger sewer.

Call in the Pittsburgh Pipe Cleaning Engineering Department TODAY for a complete survey of your piping problems.

Pittsburgh Pipe Cleaner Company offers Today one of the most Complete Engineering Services available in the Industrial Water Supply and Disposal Fields.

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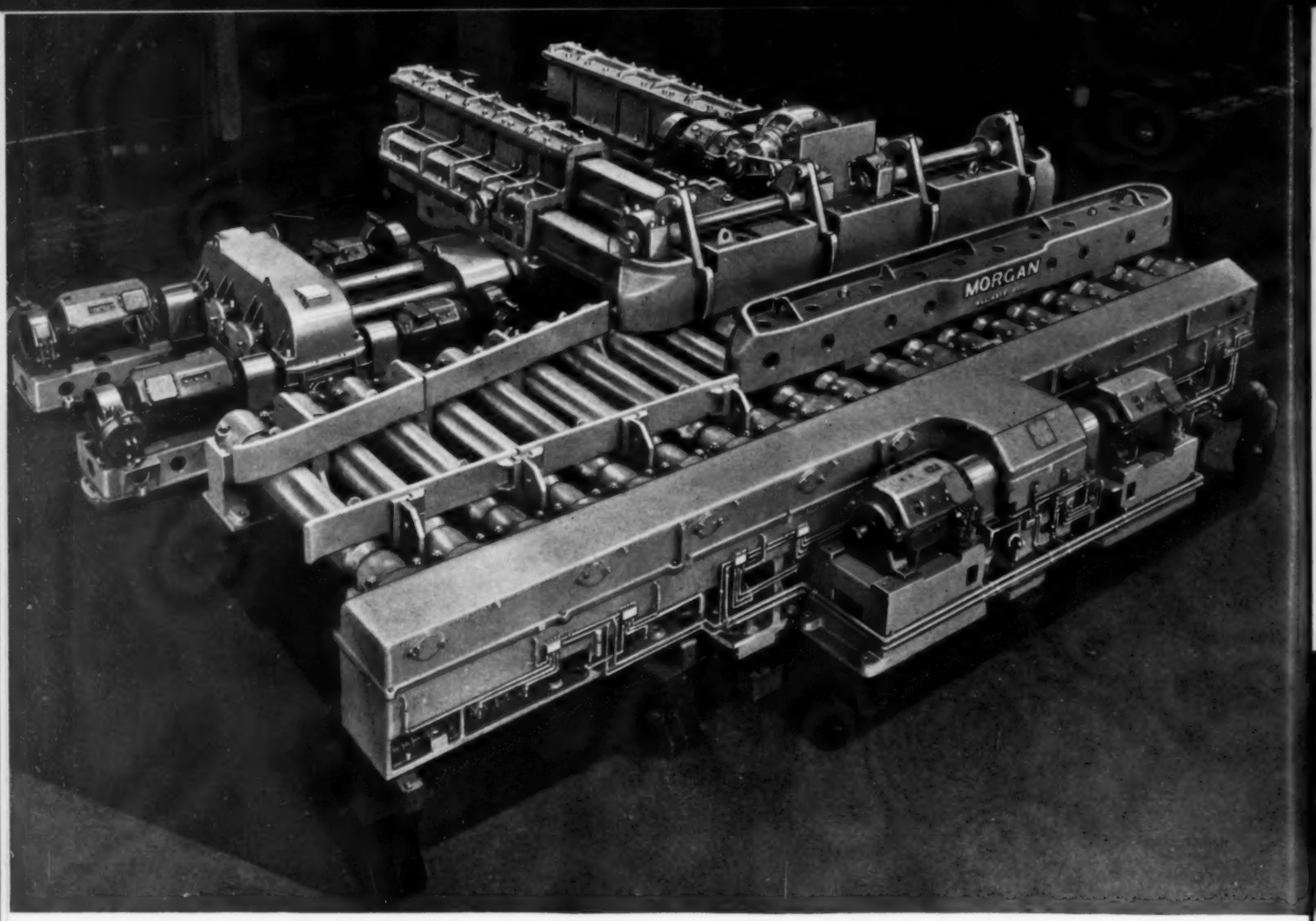


45″ BLOOMING MILL TABLE AND MANIPULATOR

Morgan 45″ Blooming Mill Manipulator with Front Mill Table. Manipulator is of the overhead type, electrically driven, with retractable heads so the table rollers can be removed without dismantling the manipulator heads. Table girders are of cast steel box section type with integral oil trough on drive side. All gears are totally enclosed, operating in oil, and have hardened teeth. All bearings are of the anti-friction type lubricated through a centralized motor operated system.

BUILT BY MORGAN Engineering

HE MORGAN ENGINEERING CO.
LLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

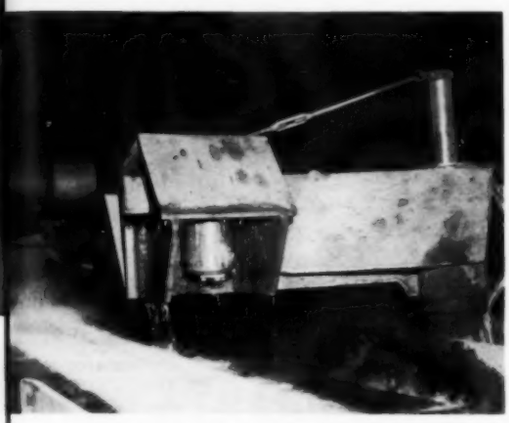
DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Equipment News...

X-RAY THICKNESS GAGE ENABLES WEIRTON TO PRODUCE UNIFORM STEEL STRIP

▲ A recently installed General Electric X-ray thickness gage has enabled the Weirton Steel Co. of Weirton, W. Va., to produce more uniform steel strip than previously was possible using mechanical gages.

Installed along the runout table immediately beyond the finishing stands of the company's 54-in. hot strip mill, the X-ray thickness gage continuously measures the thickness of strip which passes through its throat at approximately 1700 fpm.



The gage continuously measures strip thickness at 1700 fpm.

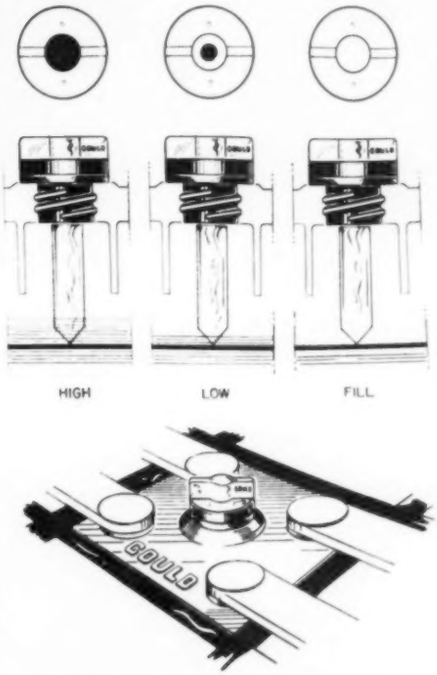
The Weirton rolling mill operators said that the G-E instrument has enabled them to reach gage on the first strip, whereas formerly four strips could go through the mill before a report on the gage was obtained. This is particularly advantageous, they said, when rolling short orders.

The operating department of the steel company stated also that because of the X-ray gage they have been able to adjust the water sprays so that the tail end of the strip is more nearly the same gage as the front end of the strip. Thus, it permits better welds on the pickle line they explained, and results in a better product for rolling on the high speed tandem cold strip mills.

As the strip leaves the last of the six finishing stands on its way down the runout table, it speeds at almost 20 mph between an X-ray tube located in a steel tank beneath the runout table and a radiation detector located above the table. It absorbs some of the X-rays passing between these units; the amount of energy absorbed being an indication of its density or thickness. Thus, without ever coming in contact with the strip, the gage continuously indicates any deviation from the desired thickness.

GOULD ANNOUNCES PLASTIC VENT PLUG

▲ The Gould Storage Battery Corp. announces a new translucent plastic vent plug, named the "Televel," which tells at a glance whether the battery needs water. Maintenance men determine electrolyte levels without unscrewing the plug. Time is saved and a monotonous chore is eliminated. In addition, unnecessary watering is avoided, filling is assured when required, passed-over cells are detected, and better supervision results.



Maintenance men can determine electrolyte levels without unscrewing plug.

The translucent plug has a cylindrical element which projects down into the electrolyte. The portion of the element which extends into the electrolyte is cone-shaped. When the electrolyte is at the correct level, the cone is completely covered. Light waves traveling down the element are absorbed into the electrolyte and not reflected. The top of the plug shows a black circle, indicating that no water is required. When the electrolyte is low, the cone is not covered by the electrolyte and light waves are reflected back up the element from the electrolyte surface. A white circle appears, indicating that water is required.

The unit is available at slight extra cost for all new Gould "Z" type batteries, both "Thirty" and "Kathanode."

PLASTIC WINDOWS GIVE PLANTS DAYLIGHT INSIDE

▲ The problem of how to provide adequate and economical lighting in large industrial structures is an old one. Artificial lighting is costly, but provision of adequate "inside daylight" has necessitated the installation of the expensive framework required for conventional windows or skylights.

The National Tank Co. has found the answer so far as its new plant at Tulsa, Okla., is concerned, through the use of translucent fiberglas and plastic sheets for the skylights and windows. The sheets admit sufficient natural daylight for most of the operations conducted in the plant. Their corrugations correspond to those of standard corrugated metal, and they can be installed in the same way as corrugated metal sheets, without framework of any kind.

Known as "Alsynite," the translucent sheets are made of fiberglas mat impregnated with "Laminac" resins. The sheets can be sawed and nailed with ordinary tools. They can be punched or drilled and fastened in

The many advantages of this type of daylight illumination are apparent in this illustration.

place with ordinary sheet metal screws or bolts. For weatherproofing lap joints, a special translucent mastic is available.

Light weight of the sheets, approximately 8 oz per sq ft, is an important consideration. The sheets will not shatter or rot; they are unaffected by climatic conditions, and are strong enough to sustain weight imposed by a snowfall. As normally installed, the material will not readily ignite nor readily support combustion.

The Alsynite sheets are made by Allied Synthetics Co. With flat corrugation, they are available in 8 to 10 ft lengths, in 4 in. increments. Width is 26 in.

OIL-TO-GAS CONVERTER AIDS FUEL SITUATION

▲ To help industry face the critical fuel situation, the North American Manufacturing Co., now offers the new "Oil-to-Gas" converter to users of industrial ovens, furnaces and boilers now fired with gas but which do not lend themselves to the substitution of direct oil burners.

The converter simply supplies high temperature air to the point in the piping where the gas and air ordinarily are mixed. At the same point, atomized oil is introduced into the hot air stream which immediately vaporizes and burns in any type or style gas burner the same as gas. Existing gas burners and piping are not altered, so that changing from gas to oil or back again is as simple as shifting gears.

Three major advantages are featured in the new converter. First, it will vaporize and burn No. 1, 2 or 3 oil without forming carbon or condensate. Second, because there is no carbon or condensate formed, there is no need for condensate return piping or periodic cleaning. Third, the entire system is completely automatic and includes flame safety devices.

The converter consists of one air heater assembly and as many insert assemblies as desired. This makes multiple zone control possible and no change in firing technique is necessary.

CHECKER DESIGN HAS STRAIGHT FLUE

▲ Solidly interlocked checkerwork at minimum cost is provided by a checker design manufactured exclusively by Union Fire Brick Co. The patented design uses two shapes, one a standard 9 in. x 4½ in. x 2½ in. brick and the other a 7¾ in. x 4½ in. x 2½ in. brick with a tongue about 1¾ in. x 1¾ in. running across each end, as shown in the accompanying sketch. This latter shape is the equivalent of a standard 9 in. brick, and carries no cost extra.

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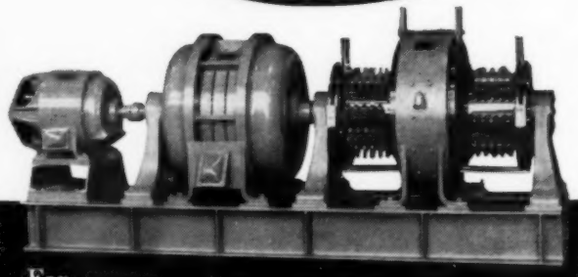

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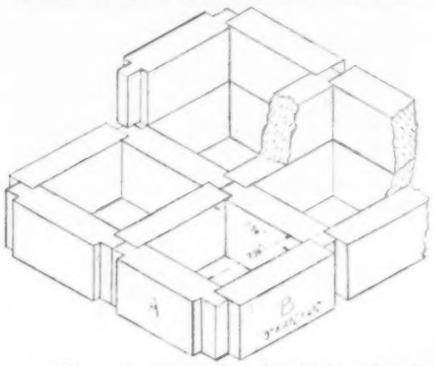
These two shapes, laid as shown in the sketch, provide solid flues, 7¾ in. x 7¾ in. If brick of 3 in. thickness are used, the flues are 7½ in. x 7½ in. Where cleanout flues are desired, a course of the standard 9 in. brick is



run from front to back of the checkerwork.

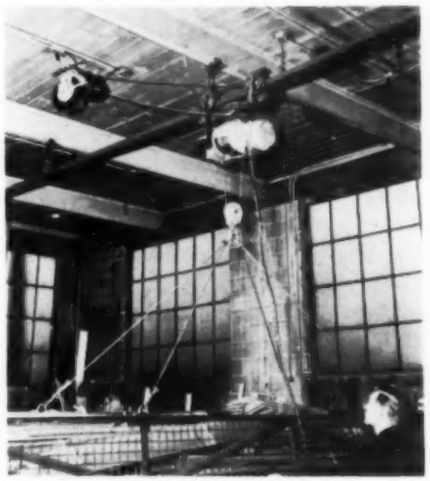
The design makes it easy to carry a straight flue, and provides an unusually rigid construction.

BRIDLE-SLING EASES HOIST PROBLEMS

▲ A four-part bridle-sling provides a simple solution to the difficult problem of hoisting such loads as sheet-steel, machinery, ship-to-shore cargoes, construction equipment and large rectangular-shaped loads like the basket-type conveyance illustrated. The large basket-like container carries fabricated sheet-metal sections from one part of the shop to another. It comprises an angleiron frame and wire mesh body.

The ends of the sling cables are permanently secured to the frame. Thimbles prevent wear where the cables engage the hoist hook. The Yale and Towne hoist handling the load is a ¼-ton wire-rope trolley-mounted unit. The load is raised and lowered by push-button control and is pushed along the trolley by shoving the load. A reel suspended from the ceiling takes up slack electrical supply cable and eliminates dangling cords. A useful chart indicating safe

The load is raised and lowered by push-button control



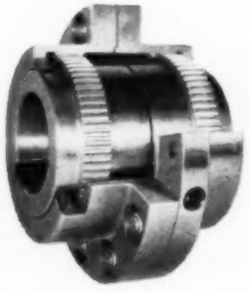
SAFE LOADS			
Sling Size	90°	45°	30°
1/4"	2,100	1,700	1,150
5/8"	4,900	3,900	2,700
1/2"	8,500	7,000	4,700
5/8"	13,000	10,500	7,200
3/4"	19,500	15,500	10,500
7/8"	25,500	20,000	14,000
1"	32,500	26,000	18,000
1-1/4"	49,000	39,000	27,000
1-1/2"	72,000	57,000	40,000

loads which can be carried by this type of sling is included above for a typical wire-rope type cable.

ANNOUNCE NEW LINE OF CONTROL TRANSFORMERS

▲ A new line of control transformers has been announced by the industrial

IT'S EASY TO UNDERSTAND
WHY COUPLING USERS SPECIFY



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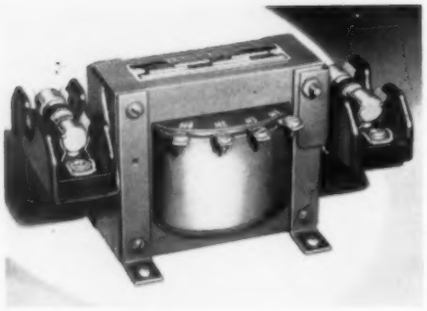


This unit was designed for use with industrial control equipment.

controller division of the Square D Co. These control circuit transformers were designed specifically for use with industrial control equipment, which is characterized by high, momentary inrush currents to the a-c operating magnet coils. The manufacturer claims the low impedance values of the transformer windings result in unusually good transformer regulation during peak current periods.

To provide secondary circuit protection, either one or two fuse and bracket assembly units can be easily mounted directly on the transformer. These control circuit transformers are compact in design, easy to mount, and are built especially for front-wired control panel use. Accessible, screw type terminals permit panel wires to run directly to the transformer, thereby avoiding splices usually required with flexible leads.

The transformers are available in 50, 100, 150, 300 va at either 50/60 or 25 cycles, and 500 va at 50/60 cycles, with primary voltages of 220-440 (dual voltage), 550, 440, 380, and 220, and secondary voltages of 110 or 24 volts.

POWER TRANSFORMERS HAVE STANDARD PARTS

▲ Pennsylvania Transformer Co. has announced that its new line of standard parts power transformers are now available in the following sizes: three phase: 10,000 kva and below, up to 34.5 kv; single phase: 5,000 kva and below, up to 34.5 kv.

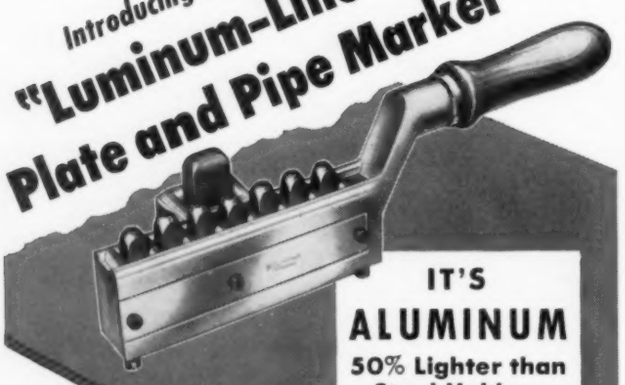
These transformers are standardized in such a way that identical parts may be used in several ratings and some variations may be made in some of the electrical characteristics.

Costs on Pennsylvania Standard Parts Power Transformers show a saving of 4 to 6 per cent, which is passed on to the user.

Since the flexibility of this design permits application in keeping with system requirements, a wide use of Pennsylvania standard parts power transformers will result in significant dollar savings to users.

USE THE
ENGINEERING MART
Page 171

Introducing the New
"Luminum-Line"
Plate and Pipe Marker



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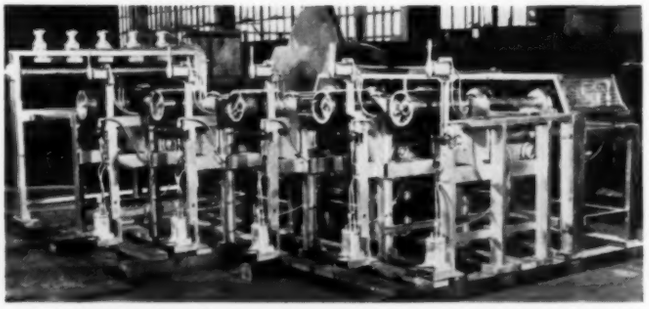

Individual strip coiling stations are stopped for loading and unloading by a pneumatically operated disengaging drive clutch synchronized with a braking mechanism. Finished coil is recovered by pneumatically operated stripper plate and buggy on each station. To permit removal of coils, mandrels are self-collapsing by snap action operating on spring loaded cam principle. Varying pressure on clutch plate controls winding tension of coils to prevent clutch overloading. The entire machine is driven from one common power line through chain and sprockets which drive individual heavy duty slip clutches.

This machine enables 2 men to do 2 to 3 times the work done with conventional strip coilers. Write for detailed information.

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Book Reviews

▲ "Powder Metallurgy" by Dr. Paul Schwarzkopf is the revised and expanded notebook of one of the pioneer power metallurgists, and makes available the "fingertip" knowledge of an expert. The book contains invaluable information about industry processing of metal powders, and the products which can be obtained. Following a review of the theories on which the art is based, the entire field of powder metallurgy is covered and its future possibilities. It thus provides an authoritative source of information for machine designers, tool engineers, electronic specialists and others who use powder metallurgical products. Published by the MacMillan Co., 60 Fifth Ave., New York, N. Y., price $8.00, 6 x 9 in., cloth bound, 379 pages.

▲ "Mathematics For Industry" by S. E. Rusinoff was developed to illustrate the application of the principles of mathematics to the practical shop problems which are most often encountered. The book will be found particularly useful in the engineering shop, drafting room, tool room, and for inspection, and makes an excellent reference book for the busy engineer. Book may be obtained from the American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Price $5.50, 5½ x 8½ in., cloth bound, 519 pages.

▲ "Strength of Materials" by Charles O. Harris was written for men below the engineering level who require knowledge of this subject in their work. This book has therefore been written for the practical man and employs the use of simplified descriptions and many illustrations to show how various problems are handled. Higher mathematics have been eliminated, thus enabling use of the book by men without higher education. Modern developments such as analysis and design of welds are emphasized. New materials now being used by industry are also discussed. The book is published by the American Technical Society, Drexel Ave. at 58th st., Chicago, Ill. Price $4.90, 8½ x 11¼ in., cloth bound, 212 pages.

▲ "Power Capacitors" by R. E. Marbury of the Westinghouse Electric Corp., covers the fundamental working principles of capacitors, the materials used in the manufacture of power capacitors, and the characteristics of the completed units. The basis of rating power capacitors, their operating limitations, types of capacitors commonly manufactured with their field of application, are also covered. The book describes the selection and use of fuses and breakers to function with capacitor units. The book will help the industrial plant engineer to gain a better understanding of the significance of power factor and the proper use of power capacitors to improve power factor. The book is published by the McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y., price $3.50, 6 x 9 in., cloth bound, 205 pages.

▲ New tables of preferred ratings for power circuit breakers have just been approved by the American Standards Association. They are the American Standard Preferred Schedules for Power Circuit Breakers, C37.6-1949, and are a revision of similar schedules issued in 1945.

The schedules are presented in four tables of ratings covering circuit breakers of the following types: indoor oil, indoor oilless, outdoor oil and outdoor oilless, and low oil content. In this 1949 revision the number of individual ratings has been reduced materially in each classification, resulting in a net over-all reduction of 43 ratings, from 121 in the 1945 Schedules to 78 in the 1949 edition. A revision of the "rated voltage" kv values to conform to the latest recommendations of the Edison Electric Institute-National Electrical Manufacturers Association Joint Committee on Preferred Voltage Ratings for A-C Systems and Equipment, and the addition of a column of "maximum design" voltage ratings for the information of the application engineer has also been accomplished, along with a change in the thermal "short time" ampere ratings from 5 seconds to 4 seconds. A "time in cycles" column has been added to Tables 1, 2, and 4.

The 1949 revised Schedules of Preferred Ratings for Power Circuit Breakers has been printed as a separate document in order to make it available immediately. It will be included in the next compilation of the American Standard for Circuit Breakers, C37.4 through C37.9-1945, the other sections of which are in the process of being revised at the present time. Copies of the American Standard Preferred Schedules for Power Circuit Breakers, C37.6-1949, are available from the American Standards Association at 35 cents per copy.

▲ The following new NEMA standard is now available for distribution: NEMA Standards for Series Capacitors, Publication No. 48-135. These standards cover the rating, manufacturing and testing of capacitor units rated ½ kva and larger for series connection in low-frequency alternating-current circuits. Series capacitor assemblies are also covered, and the terms used in the publication are defined. 20 pages, 8 x 10½, $1.50.

▲ Extensive new data on the cold extrusion of steel is now available to the American public in a 138-page report released recently by the Office of Technical Services of the Department of Commerce.

The new report covers work done for the Army Department by the Heintz Manufacturing Co. to adopt German-developed technology in this field to American productive processes.

An important section of this report deals with the development of efficient, automatic "phosphatizing." Phosphatizing, the application to steel of a lubricating finish for cold extrusion, is the key to the success of this process.

PB 96704, *Cold Shaping of Steel—Summary Report,* 138 pages, is available at $17.50 in photostat form, $5.50 in microfilm. Orders should be addressed to the Library of Congress, Photoduplication Service, Publication Board Project, Washington 25, D. C., accompanied by check or money order payable to the Librarian of Congress.

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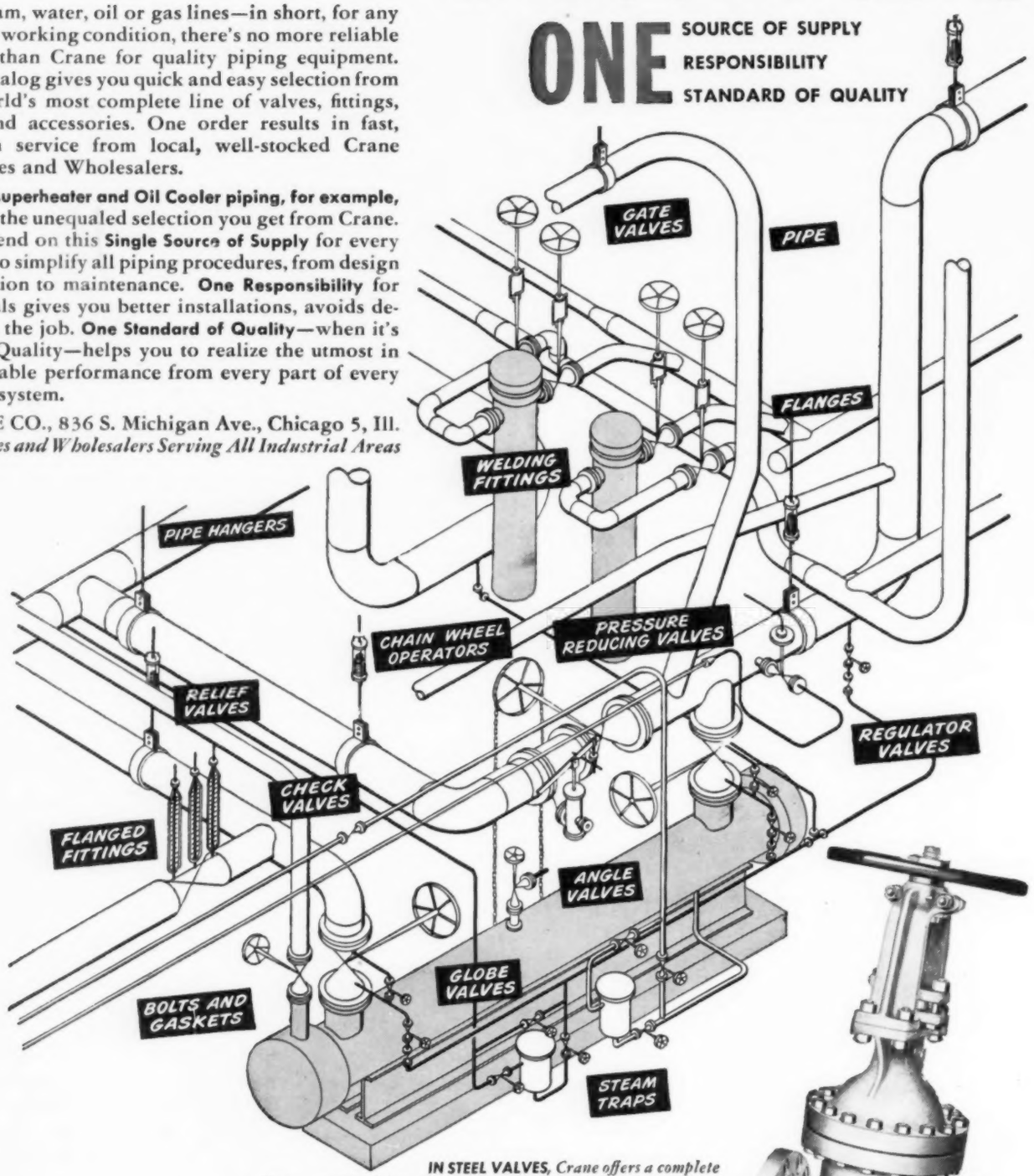

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